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The Haldimand-Norfolk Environmental Appraisal

Volume 1/Inventory and Analysis

Haldimand-Norfolk Study

Victor Chanasyk

July, 1970

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Mr. Nigel H. Richardson,
Study Director,
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Ministry of Treasury,
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Queen's Park,
Toronto, Ontario.

Dear Mr. Richardson:
I am pleased to submit to you the Environmental Appraisal of land-based resources for the Haldimand-Norfolk Study. It is presented in two basic parts: an Inventory and Analysis of certain physical and cultural resources and a Synthesis of these elements.

It is only in very recent years that the full environmental implications of world population increase, urban and industrial expansion and high consumption of resources and goods has been fully understood. Recognition of this problem must necessarily be based in understanding that the world environment works as a closed system with not as much latitude for interference in environmental processes as had been commonly assumed.

The Haldimand-Norfolk Study Area represents, within limits, a microcosm similar to the global system of resources and natural processes. It, too, has some aspects of a closed system, and even more so than other regions for many of its resources are relatively unique and it cannot depend upon neighboring regions for those it does not possess or cultivate. And so it is encumbent upon the residents of the area to recognize the limitations of activity and the importance of their integration—from heavy industry to recreation—in order that the people may plan for themselves as high a quality of life as is possible.

In the light of these circumstances it is right that your vision should be acknowledged in asking that so comprehensive a study as this Appraisal be conducted as an integral part of the planning exercise for which you have responsibility.

I wish, as well, to acknowledge fully the contribution of the various specialists from universities and government departments whose contribution is central to a study as comprehensive as this one. While the terms of reference did not include the development of new analytical methods, I am sure you will find that this report represents a sensitive search into critical resources and phenomena which will be helpful to you in the formulation of a regional planning strategy.

We collectively appreciate the assistance received from the various Ministries concerned, as well as your understanding of the complexities of such a comprehensive investigation. Under these circumstances the skilful editorial contribution of Miss Karin Lenman of your Ministry is particularly appreciated.

The results of the study are respectfully submitted for your consideration.

Yours sincerely,

Victor Chanasyk

Victor Chanasyk,
Principal Consultant

Office of the Treasurer of Ontario
March, 1972

In an era when all of us are becoming increasingly aware of the need to protect our natural environment, the needs of industry and urban growth present a serious challenge. When the impact of such development on a very large scale is to be experienced by an area rich not only in agriculture and forestry, but in recreational, ecological and historic resources, it becomes imperative to plan the use of land with the utmost care. This was the situation in the Haldimand-Norfolk area of southern Ontario when the Steel Company of Canada decided to build a new steel mill there.

But knowledge must precede plans. The Director of the Haldimand-Norfolk Study therefore asked Professor Victor Chanasyk of the University of Guelph to undertake a complete appraisal of the natural, recreational, landscape, agricultural and scenic resources of the Study Area, including parts of adjoining counties—a total area of 2,000 square miles. This work was carried out with the cooperation of a Steering Committee drawn from several Government departments.

While the Ontario Government is not necessarily committed to the findings and recommendations of the report, I believe that the Haldimand-Norfolk Environmental Appraisal is a unique document. Perhaps never before has such an extensive range of information about almost every aspect of the physical environment—from fisheries to historic buildings, from soil types to climatology—been assembled as the basis for regional planning. In congratulating Professor Chanasyk and his colleagues for their work, I commend the report not only as an invaluable source of information but as a model of how we should approach the task of safeguarding our natural heritage.

W. Darcy McKeough
Treasurer of Ontario

Contents

Origins

The modern counties of Haldimand, Norfolk and Brant were formally created following legislation in 1849 which substituted the county for the district as the unit of local government in Ontario.

Haldimand
Haldimand, on the lower Grand River and fronting on Lake Erie, was formed in 1850 with the centrally situated village of Cayuga as county seat. It was called after Sir Frederick Haldimand, who had been Governor of Quebec when the first settlers came into the County. It was made up of 10 townships: Canborough, North and South Cayuga, Dunn, Moulton, Oneida, Seneca, Sherbrooke, Rainham and Walpole. The last two had previously been part of Norfolk.

Norfolk
Norfolk County, with the county seat at Simcoe, was also instituted in 1850. It was named after Norfolk, England, by John Graves Simcoe, the first Lieutenant-Governor of Upper Canada (1791-96). It was a union of eight townships: Charlotteville, Houghton, Middleton, Townsend, North and South Walsingham, Windham and Woodhouse. The townships, too, reflected Simcoe's preference for solid English names. Norfolk, located just west of Haldimand, is not part of the Grand valley. But its history has been affected by Big Creek and other streams within its boundaries; and it has had the advantage that a large part of its shore is protected by Long Point which juts arm-like into Lake Erie.

Brant
Brant, with its county seat at Brantford, both named after the Mohawk chief, Joseph Brant, was established in 1852. A Y-shaped inland area north of Haldimand and Norfolk, it drew together six townships in the fertile Grand River valley: South Dumfries, formerly in Halton County; Brantford, Tuscarora and Onondaga, in Wentworth; and Burford and Oakland, in Oxford.

First Inhabitants: The Indians

Although some stone tools, bone and shell ornaments, and earthworks, have been found, which indicate that Indians roamed the woods of the area a thousand years ago, much more extensive archaeological work is needed before this ancient past can be described. Concerning the Indians met by the French after 1600, however, there is a body of information, which is gradually being increased by such discoveries as that of a skeleton and pottery remnants on the Harry A. Shelly farm near Port Rowan in 1968.

The Attiwandarons or Neutrals
The Indians who were known to the Europeans in the early days of New France were the Attiwandarons. They were related to the Five Nations Iroquois (after 1722 the Six Nations) of the Mohawk valley south of Lake Ontario. The Attiwandarons are believed to have fled north of Lake Erie to escape the Senecas about the 14th century, though some recent interpretations suggest that commercial ambition was the motive behind their migration. They were renamed the "Neutrals" by the French, because they did not join either the Hurons, who lived around the southern shores of Georgian Bay, or the Iroquois, in the 17th century struggle for control of the furs of the Great Lakes.

The Neutrals, indeed, benefited by the flint beds in their possession which enabled them to supply both sides with arrowheads and tools. Besides being keen traders, they grew tobacco, squash, corn and beans — the region is noted today for some of the same crops. The Neutrals lived in villages, which had to be moved every 10 or 20 years owing to unsanitary conditions or soil exhaustion. One of the villages was designated "Notre Dame des Anges" by the French; it may have been in the vicinity of Brantford or Caledonia. Others were probably at Turkey Point and Port Dover.

After receiving information about the Neutrals from the Hurons and the *coureurs de bois,* French missionaries visited them. The Recollet father d'Aillon from Huronia and his two companions in 1626 were the first known white men in Haldimand. They reported its fine forests, game and fish and ideal weather; and they mentioned 28 Indian villages "made like those in the Huron country".

In 1640, the Jesuit fathers Brébeuf and Chaumont journeyed down the Grand "with the intention to preach the Gospel" to the natives. But no organized mission resulted. The Huron traders, afraid of losing their profitable position as supplier of furs to the French, did all they could to discredit the missionaries and thus to prevent them from making effective contacts with the Neutrals.

The Iroquois
By mid-17th century, the Iroquois were able to obtain steel from the Dutch in the Hudson valley, and were no longer dependent on the Neutrals for flint. Consequently, after defeating the Hurons in 1649, the Iroquois turned southward and eliminated the Neutrals as well. They wanted only to establish their monopoly over the hunting grounds north of Lake Erie, not to move into the region. But they continued to mold its history, for their presence south of Lake Ontario prevented the American frontier from pushing northward through the colony of New York and also discouraged extension of French settlement westward. After 1650, therefore, Haldimand, Norfolk and Brant were unpeopled for about 130 years, except by trappers and nomadic bands of Mississauga Indians from the Manitoulin district.

The Mississaugas
These Indians were part of the Algonquin group. By 1700 they were spreading southward across a considerable area from north of Lake Ontario to Lake St. Clair, and supplanting Iroquois influence therein. The Mississaugas lived mainly by hunting and fishing, for which this portion of southwestern Ontario afforded plentiful opportunities. They established their claim to the land by right of occupancy over the years.

French Traders and Explorers

Thus Haldimand, Norfolk and Brant were not colonized from New France. Yet they were important to her traders and explorers, since they lay directly on what became one of the main French routes to the Upper Lakes and the Mississippi valley.

Joliet

The Grand River was frequently used as a link in the portage between Lakes Ontario and Erie. Louis Joliet, for example, took this route in 1669 on his return trip after searching for copper in the northwest.

Dollier and Galinée

The Sulpician missionaries, François Dollier de Casson and René de Galinée, used the same portage on their way from Montreal to the Sault. These two missionaries and the seven other Frenchmen in their party in 1669-70 were the first white men to sojourn in the neighbourhood of Long Point. They took possession of the "Lands of Lake Erie" in the name of King Louis XIV, and erected a cross to which were affixed the arms of France.

Galinée drew a map of their travels, which, inaccurate though it was, is the first known map of the Grand River. He also left a written description of the abundance of wild life, fruits and nuts, and of the delightful site on Black Creek on which they had built a log cabin to serve as their dwelling, chapel and fort. The location of that wintering-spot has been indentified and marked by a cairn just east of Port Dover. A tall cross on nearby Brant Hill commemorates the cross planted by the French. Unfortunately Galinée did not make a sketch of the cabin which had sheltered them and their provisions through the severe months, and only a general idea of its arrangements can be gained from his writing.

Such expeditions enlarged French knowledge of the Lake Erie and Grand River region. But again, no mission, trading post or other French influence remained. Norfolk, Haldimand and Brant, like the rest of Ontario, were still a forest wilderness when New France passed to Great Britain in 1763.

British Rule and The United Empire Loyalists

The first years of British rule brought no change to the three counties, for official policy was opposed to settlement of Ontario in order to avoid irritating the Indians of the Ohio country who had been allies of the French. It was the responsibility of providing homes for the Loyalists toward the end of the American Revolutionary War which eventually caused Britain to alter her policy.

Recognizing the claim of the Mississaugas to the large area which they had occupied, Britain began purchasing it from them so that there would be a place for members of the Six Nations and other persons from the old colonies who had retained their British allegiance. On May 22, 1784, in return for the sum of £1180, the Mississaugas ceded to Britain the parcel of land between Lake Ontario and Lake Erie which had roughly the boundary points of Burlington, Elora, and the mouth of Catfish Creek — about half-way between Port Stanley and Port Burwell. The exact boundaries were not clear in the agreement to sell, and were only determined later after surveyors' examination.

The first recorded settlers in Norfolk, Haldimand and Brant — three of the counties which would develop out of this cession — were Loyalists, with a few exceptions such as the amateur doctor, John Troyer. Troyer was a Pennsylvania Mennonite who took a lot about one and a half miles east of Port Rowan, and apparently hoped to establish a colony of Tunkers along the lakefront. He soon had a reputation in Norfolk both for ability and for eccentricity. His log house and blockhouse stood until about 1930, and some Troyer relics have been preserved in the Eva Brook Donly Museum at Simcoe.

The Loyalists were followed by many other Americans who came not out of loyalty to a cause, but as part of a North American movement of people in search of rich new land.

The Settlement of Norfolk: Governor Simcoe and the Loyalists

The history of Norfolk owes a great deal to both Governor Simcoe and the Loyalists. His efforts to stimulate settlement through generous grants of land, implements, seed and other supplies were supplemented by the natural attractions of the climate, sheltered bays, and "plains" interspersed with groves in the Long Point country. The result was that a number of Loyalists who had earlier fled from New England and New Jersey to New Brunswick were induced to undertake a second migration over the laborious miles to Norfolk. The first to arrive were the families of Frederick Mabee, Peter Secord, and Peter Teeple in 1793.

Other Loyalists from New Brunswick and from various American states came in succeeding years, settling in all the townships except Houghton on the west, and giving rise to little communities like Port Ryerse which was called after its founder, Colonel Samuel Ryerson. Rainham and Walpole Townships, at that time part of Norfolk, were also settled initially by Loyalists — the Hoover families, Swiss from Pennsylvania.

By 1812, Norfolk had a population of 3000. Only a few of these were British immigrants. The great majority were Loyalists, and their decendants are among the distiguished citizens of the present county.

Simcoe, always concerned with the improvement of provincial defences, had considered the settlement of Norfolk essential because of its commanding location on Lake Erie. In 1793 he ordered the military reconnaissance of the shore from the mouth of the Grand to Long Point, and in 1795 the surveying of land for townships. On his first visit to the region in the autumn of 1795, Simcoe was so impressed by its agricultural and strategic possibilities that he chose 600 acres on the cliff at Turkey Point as the site for a metropolis, to be named Charlotteville in honour of the Queen. He had in mind a military colony which would be the first line of defence for an interior capital at London. In a letter (now in the Public Archives of Canada) to Lord Dorchester, the Governor-General at Quebec, he included a map showing his plan. On the heights would stand the town with government buildings and fortifications. On the Point below would be a naval station with shipyard and wharves. A mill would be constructed on a creek to the east, and

a road to the north giving connections inland.

The scheme was blocked by Lord Dorchester, the Colonial Secretary, and Simcoe's ill-health which forced him to leave the province in 1796. In 1804, a two-storey structure, part court house and part jail, was erected; it was used also to house troops after the outbreak of war in 1812. The hostilities focused attention again on the military potential of Long Point Bay. Fort Norfolk was built on the hill at Charlotteville to protect the naval establishment which was proposed for Turkey Point but which had not materialized by the end of the war. The fort is shown on a sketch plan dated 1815, and has been described as "a stake fort, the walls consisting of a double row of pointed stakes, the two rows being several feet apart, and the space between filled in with earth". The cholera epidemic of 1813 prompted the erection of a rough hospital on the outskirts of Charlotteville. Apart from these developments, only a tavern or two, and one or two houses were ever built. All that remained into the 20th century were marks of the trenches surrounding Fort Norfolk. Its location has been designated by a cairn.

Charlotteville and Vittoria: Capitals of the London District

The greatest activity at Charlotteville was undoubtedly that connected with the court house, which from 1804 until 1815 served the whole London District. When in the latter year the Courts of Quarter Session were removed to the more suitably located village of Vittoria, Charlotteville went into rapid decline. Until 1825, when the seat of government was changed to London, the District was administered from Vittoria. The comfortable brick court house erected there at a cost of $45,000 in 1816 was destroyed by fire nine years later.

Norfolk had proved to be too much on the periphery of the London District to furnish a convenient judicial and administrative center. Nevertheless, Charlotteville and Vittoria enjoyed prominence during the time when they were the capitals of western Ontario. The growth of Vittoria after ceasing to be the District town, unlike that of Charlotteville, was assured by various circumstances. It had a mill, an inn, and — very important — a crossroads location. It also had the first post office in the county, a Division Court, the registry office until Simcoe was made the county town in 1850, and a strong Masonic Lodge.

The Baptists built their first church at Vittoria in 1807, which they replaced by a substantial brick building in 1851. The Anglicans used the court house for services until it burned in 1825. One of the first common schools and the first grammar school in the county were near Vittoria. The grammar school became famous because it was attended by the sons of the Loyalist Colonel Joseph Ryerson, including Egerton who was to be the father of the Ontario school system. It is not surprising that the township hall was placed in 1849 at Vittoria, important as the village was on these several counts and the largest in Charlotteville Township. Ryerson's colonial-style home built in 1818 and Christ Church (Anglican) dating from the 1840's are buildings of historic interest at Vittoria.

The Loyalists in Haldimand and Brant

The Loyalist settlements in Haldimand and Brant were unlike those in other parts of the province, for they included Indians as well as whites. It is ironic that the Iroquois returned as refugees to the very region over which their ancestors had held sway. Some of the chiefs preferred the Bay of Quinte at the eastern end of Lake Ontario, where Governor Haldimand intended to place the Six Nations in recognition of their service to Britain during the revolutionary war. But Joseph Brant held out for the Grand valley. In his opinion is was the only part of Ontario to compare with the Mohawk valley lost under the Treaty of Paris in 1783 by which Britain recognized the independence of the American colonies.

The majority of the Six Nations Loyalists followed Brant to the land granted under Haldimand's Proclamation of October 25, 1784. It was a large tract, extending 6 miles on each side of the Grand River from the mouth to the source (which was not realized to be so far north). It comprised all eight townships then in Haldimand, four in Brant (Tuscarora, Onondaga, Brantford, South Dumfries), three in Waterloo, and two in Wellington County. Although arrangement was soon made for the boundaries to be drawn in straight lines following the general line of the river, rather than curving with its bend, traces of the original grant are found in the shapes of Brant County and some of the townships.

Brant felt that the Indians could not adequately use such a large territory for agriculture; he believed that they could learn from the example of experienced white farmers, and that money obtained for their land would help to supply them with guns, blankets and other articles. Sincerely, therefore, but it would seem unwisely, he proceeded to give away, lease or sell large blocks. The subsequent history of the Mohawk tract embraced doubts of Brant's regard for his own people, quarrels with the government as to whether the Confederacy had or had not the right of disposition of the land, defaulting in payments, legal disputes, speculation, few actual dividends for the Indians, and mounting bitterness against the whites. The facts relating to the alienation of the lands are too complex to be accurately detailed here.

Although some of the white Loyalists in Haldimand and Brant settled outside the Indian grant, for instance, in Burford Township, the majority in these two counties came as the result of Brant's gifts, leases or sales. He was a warm friend of Colonel John Butler, beside whom he had fought against the revolutionaries in New York. It is not surprising, then, that veterans of Butler's Rangers were foremost among those who received 999-year leases: Henry Nelles and Adam Young (both of German descent, as were many of the Haldimand pioneers) in Seneca and Oneida Townships; John Huff in North Cayuga; John Dochstader in South Cayuga; Walter Butler Sheehan and Hugh Earl in Dunn.

Similarly, John Smith, John Thomas, Alexander Westbrook and Benjamin Fairchild were all friends of Brant from the war years, whom he encouraged to settle in Brantford Township. South Dumfries and Moulton are examples of

whole townships sold by Brant. This pattern of large-scale disposal did not cease with Brant's death in 1807. Sherbrooke Township, for instance, was conveyed by the Mohawks to the lawyer William Dickson as a retainer for his professional services.

Mohawk Historic Sites in the Grand Valley

In spite of all the ensuing controversy, the grant of 1784 introduced into the Grand valley elements which have enriched it historically. The Mohawks gave the name of Brant's Ford to their chief village at the place where Brant had thrown a boom across the river. Numerous other villages and townships and streets in Haldimand and Brant Counties carry Indian names. Her Majesty's Chapel of the Mohawks, dedicated in 1788, is the oldest Protestant church in Ontario; its church bell was the first to toll in the province. The stained-glass windows of the Chapel portray the history of the Six Nations, and it houses part of the communion service which was presented by Queen Anne to Brant's grandfather and kept safe by the Mohawks through the troubled years of the American Revolution and their migration. In the churchyard is Brant's grave. The Mohawk Institute for the training of Indian boys and girls was founded by the New England Society which began missionary work in the valley in 1827.

Other signs of the Indian heritage are Brant's momument in Brantford, a memorial to the Six Nations; Mohawk artifacts in the Brantford museum; and "Chiefswood", near Middleport, the birthplace of Pauline Johnson, the chief's daughter and Canadian poetess. Of particular interest is the village of Ohsweken at the heart of the reserve in Tuscarora Township, with its Council House, and its reproduction of an ancient Iroquois village. There on summer Sundays demonstrations of basket weaving and beadwork, wood carving, flint chipping and Indian dances in full regalia may be seen.

Loyalist Life

The first tasks facing the early settlers in the three counties were those common to the Ontario agricultural frontier — tree-felling, clearing and building. The hardships were many until the houses were closed in, the first crops of Indian corn were harvested to produce cornmeal for "johnny-cake", and some stock was acquired to provide milk, meat and wool. Since there were only blazed trails through the woods following the lines of the old Indian paths, the farms faced the water as along the St. Lawrence. The modes of travel were by foot, horseback and boat. The farms, therefore, had to be self-sufficient; and home remedies for illness were all-important, since doctors were scarce.

The earliest industries sprang from the daily needs of the pioneers: notably grist and sawmills at places where water-power was available. The most famous is the Backhouse mill erected a little north of Port Rowan in 1798. First a sawmill, then a gristmill, it was in continuous operation longer than any other mill in the province, and it stayed in the Backhouse family until purchased by the Big Creek Conservation Authority in 1955 for a park and agricultural museum.

Not only did the mill sites become centers of expanding settlement, but the sawmills also made possible the building of frame houses, which were considered a step forward from the initial log houses. Gradually the more well-to-do families erected frame dwellings in typical straight-line, symmetrical Loyalist style: rectangular shape, the long side facing the road with a door in the center and a window on each side, and frequently a lean-to kitchen at the back. The front doorway was the striking feature. The door was usually flanked by panes of glass and sometimes had a half-moon glass above. Later in the 19th century, ornate front porches or verandahs were often added. In the many sandy sections of Norfolk, where agricultural prosperity lagged, the progression from the log cabin to the frame home was slower than in the areas of richer soil such as those around Port Rowan, Vittoria and Simcoe or in the Grand valley. Consequently this stage of Loyalist architecture is missing in much of Norfolk County.

The lack of schools was another difficulty for the Loyalist settlers. Children received only what education their mothers could give until there were enough families in a community to hire a teacher and open a school, as at Burford in 1808, Canborough in 1809, or Fairchild's Creek in 1812. The pioneers lacked religious services also except for the Anglican ministry to the Mohawks, the Methodist "saddle-bag" preachers who began to work in the Long Point country and the Grand valley in the 1790's, and the occasional Baptist or Presbyterian clergyman who conducted worship in settlers' homes.

The foundations of agriculture and milling and of social institutions were thus laid by the Loyalists and the "post-Loyalists" from the United States. Yet settlement was only in small pockets, especially in the large parts of Haldimand and Brant which were Indian lands. General progress was slow, except at Long Point where the farmers by 1797 were actually producing a surplus of wheat and by 1800 had more cows per farm than the rest of the province.

The Effects of War

The War of 1812-14

Much of what had been accomplished in Norfolk, Haldimand and Brant was destroyed by the War of 1812 with the United States. The location of the counties between the military frontiers of Niagara and Detroit made them vulnerable to American attack and of economic and strategic value to Britain.

During the war, Burford was a place of considerable importance for the concentration of troops, which could be used for reinforcements to the west, east or south. On the lake, Fort Norfolk was a station for British troops, and Long Point Bay a base of supplies for British naval forces. The many recent arrivals from the United States presented the problems of disloyalty and neutralism. Port Dover, however, was a center of recruitment by General Isaac Brock and his point of departure for the capture of Detroit, where the Norfolk militia played a useful role. Six Nations braves aided in the victory at Queenston Heights and in other campaigns on the Niagara front, and also in the defence of the Grand when the Americans advanced inland in 1814.

The war increased the demand and the prices for everything produced in the counties, and the mills were kept active. Hamlets on the water like Port Ryerse and Port Dover were busy with ships calling for lumber, grain and flour. At the same time, the war made articles which had to be bought, such as salt, more expensive. Moreover, harvesting and sowing suffered during the absence of men in the Haldimand or Norfolk militia.

Most serious of all were the results of the American invasion in 1814. Port Dover, with its 20 houses and barns, three sawmills, three flour mills, and three distilleries, was destroyed. Many farms were laid waste, and horses, cows and hogs killed. Mills were a prime target. Those at Port Ryerse were burned, along with Finch's mill between Port Ryerse and Turkey Point, Malcolm's mills in Oakland, Sovereign's mill at Waterford, Culver's mill at Simcoe, and others.

Only the Backhouse mill, the Tisdale mill at Vittoria, and the Davis mill at Simcoe, survived. Capital was scarce in Upper Canada, and it was years before the area recovered from these blows to the economy. In contrast, the development of a place like Simcoe, where houses and a mill had escaped destruction, was little harmed. In the 1820's, when Simcoe acquired a post office, it had three stores, two grist mills, one carding mill, two distilleries and one tavern. By 1837, when Simcoe was made the capital of the new Talbot District, it was a "very thriving, smart little village" with a stone court house and jail.

The Rebellion of 1837-38

Also unsettling to the three counties were the provincial economic crisis of 1836, which reflected American and world conditions, and the political disaffection culminating in the Rebellion of 1837. As part of the western Ontario frontier, many people in the three counties were critical of the privileged position of the Family Compact, but few were willing to carry opposition to the point of armed uprising. At the settlement of Scotland, however, a band was rallied by Dr. Charles Duncombe and William Matthews who planned to attack Brantford and Hamilton and join forces with William Lyon Mackenzie.

What would have happened to the communities on the Grand had the rebels succeeded can only be surmised. Mackenzie's failure at Toronto enabled forces under Colonel Allan MacNab to march to the protection of Brantford, where both Six Nations Indians and white residents offered help. A historical plaque in Scotland records that the "local Patriots", disheartened, scattered during the night and Duncombe fled to the United States. But the threat of war persisted into the year 1838 with border incidents and the possibility of another American invasion.

The troubles of 1812-14 and 1837-38 had a unifying effect on the people. They had successfully faced a common danger, both from abroad and from renegades in their midst. On the other hand, economic instability and fear of attack had slowed the settlement and progress of the counties.

The Era of Roads and Canals: 1815-1850

Between the end of the War of 1812 and the middle of the century, increasing population and improved transportation were significant and interacting factors in the advance of Haldimand, Norfolk and Brant from frontier counties to more mature communities.

British Immigration

Conditions in Britain after the end of the Napoleonic Wars in 1815 led to a great interest in emigration, and for the first time a substantial number of people came directly from the British Isles to the three counties. An influx of English (some from the wealthy gentleman class) into Moulton, of Scots into South Dumfries and Oneida, and of Irish into Walpole, North Cayuga and Seneca, changed the ethnic composition of the region and filled in the spaces between the earlier patches of settlement.

Surrender of Indian Lands

Settlement accelerated in Haldimand after the Six Nations made formal surrender to the Crown on April 19, 1831 and February 8, 1834 of their residual lands along the lower Grand. In the next decade Brant, too, was opened to settlement following the surrender on January 18, 1841 of the unoccupied Indian lands in that county. These surrender documents represent a change in government policy from that of 1784. The experience of the intervening years — large sections of the original grant not in use by the Indians, constant white encroachment and resulting attrition of the Indian tract, attendant friction and resentments — all suggested the advisability of segregation. Accordingly, the Six Nations were now placed upon a reserve in Tuscarora Township on the west bank of the Grand, an area less than one-tenth the size of Haldimand's grant. The proceeds from the sale of the surrendered lands were to be administered by the Crown for the benefit of the Indians.

The Mississaugas, upon receiving a grant near Hagersville in 1847, returned to the area. They added another element to the Indian population, for they stayed separate culturally and politically from the Mohawks.

New Industries

For some years after the War of 1812, American immigrants were not welcome in the province. Nevertheless, they continued to come, and they contributed greatly to the material progress of the three counties. The family of Joseph Van Norman of New York state, for instance, used the abundant bog ore deposits in southern Norfolk to build an iron manufacturing business which at times employed 200 men. Their blast furnace, which was the first successful smelter in Ontario, closed about the middle of the century when the local ores were exhausted. But for some 30 years it had supplied high quality iron kettles, stoves, agricultural implements and mill castings, all very much needed in the new country, and it had made Normandale a port for the shipment of iron products to distant places. The Van Normans also had the contracts for building some of the early roads and for the first lighthouse at the eastern end of Long Point in 1830.

Another ex-American, Hiram Capron of Vermont, who for a time was associated with the ironworks at Normandale, is best known as "King" Capron, the founder of the village of Paris at the "forks of the Grand" where the Nith joins the main river. He was drawn there by the picturesqueness of the site and the prospect of manufacturing plaster of Paris from the gypsum beds in the neighbourhood. Capron was one of the most efficient of the planners and developers who ushered in a new age of urban living and solid, if modest, business and industry. Under his guidance Paris soon had a school and Mechanics' Institute, the forerunner of the public library; Anglican, Wesleyan Methodist, Presbyterian, Baptist and Roman Catholic churches; and public and private buildings in cobblestone — a style of architecture derived from upper New York. He saw to it, also, that Paris had, for that day, good communications with the outside by means of a bridge across the Grand River and repairs to the old Governor's Road which Lord Simcoe had built in 1793 to connect London and Hamilton. The two rivers, the road, and the gypsum, were all influential in the early history of Paris.

Improvement of Roads

The impetus to road building came not only from enterprising individuals like Capron at Paris or Ignatius Cockshutt who formed a toll-road company at Brantford. The government, as a result of the events of 1812-14 and 1837-38, was convinced of the importance of roads for the better movement of troops. And for the farmers, as population grew and land away from the water was cleared, roads were essential if they were to have access to the mills and the service industries which tended to group around mill sites. Consequently, by 1850 the counties were crossed by several main roads and contained numerous minor roads.

The multiplier effects which advances in transportation had here as elsewhere can be demonstrated by the "Plank Road" completed from Port Dover to Hamilton in 1843 (now Highway 6). It gave Norfolk County connections with Hamilton and Toronto, and to a large extent determined how the northern part of Haldimand would develop. The isolation of the back townships was broken, and settlers flowed in. The villages of Jarvis, Hagersville and Caledonia sprang up at the crossroads to supply the facilities of blacksmith shops, livery stables and taverns for the travellers by stagecoach. Norfolk and Haldimand were also fortunate in gaining an east-west thoroughfare in the "Talbot Road" (now Highway 3), which Colonel Thomas Talbot had promoted to link his settlers in Elgin County with both Niagara and Detroit.

The plank roads, though smoother than the "corduroy" log roads, did not prove durable. Indeed, traveling in any conveyance through the area, even after gravel roads became common later in the century, remained uncertain and uncomfortable until the hard surfaced roads of the post-World War I period. The keeping up of bridges was a difficulty as well. When roads were extended, the Grand River, which had been an asset to the earlier settlers, became an obstacle to be spanned by bridges. Fords and ferries were not adequate for the increasing traffic. Unfortunately, flood control of the upper Grand was not achieved until recently. The people of the valley were therefore faced with the discouraging and costly task of replacing many a bridge carried away by the annual spring floods.

Improvement of Water Communications

Vital as were the roads and bridges to the three counties, the biggest economic boost in the first half of the 19th century came from the improvement of navigation. In the 1820's and 1830's, Ontario was caught by the "mania for canalling". A dam was constructed at Dunnville in 1829, where the waters of the Grand were diverted to a feeder canal to operate the locks of the new Welland Canal. Dunnville owed much of its early growth to these developments. It had almost unlimited water power, and its shipping facilities made it the market for the lumber and later for the grain of the surrounding townships. The expansion of trade on Lake Erie following the opening of the American-built Erie Canal and the Welland Canal to Lake Ontario gave rise to the new village of Port Dover as a shipbuilding center and a shipping point for wheat and lumber.

The canal era greatly stimulated the lumbering industry in all three counties. Their magnificent natural forests had been impediments to the pioneer farmers, though supplying local needs for logs, posts and planks. Now those forests were exploited for square timber to ship down the St. Lawrence or to the United States. For a few years, lumbering was more important than agriculture in the economy of Haldimand, Norfolk and Brant.

The Grand River was made navigable as far as Brantford through a series of locks, dams and canals constructed by the Grand River Navigation Company chartered in 1832. By 1861 the company was insolvent, since the railways had taken over the carrying trade and it was no longer profitable to keep dams and locks in repair. Yet for Haldimand and Brant the age of Grand River navigation had been a dynamic one. The dams were a source of power for new grist mills and sawmills and distilleries. The markets of the world were made accessible to the inland townships. The articles of trade were a

commentary on the changes that had taken place in the economy. Shipments of lumber, at first very important, gradually declined, the trees having been cut too prodigally. The shipments of wheat, barley, salt pork and liquor and of gypsum from the neighbourhood of Cayuga and Caledonia, increased. Up the river came growing quantities of manufactured goods, which relieved the austerities of frontier life. A passenger service was operated as well. The famous paddle-wheel steamers, *The Red Jacket* and *The Queen,* reminiscent of the Mississippi, carried businessmen, shoppers and holidayers from Brantford to Buffalo in 24 hours.

Villages and Towns

The navigable river, like the improved roads, gave birth to villages. Cainsville, Newport, Middleport, Indiana, York and Cayuga became busy depots. But the biggest beneficiary under the navigation scheme was Brantford. The surrender of the village plot by the Mohawks in 1830 had paved the way for unrestricted settlement. Various ethnic groups — English, Welsh, Irish, Scots, New Englanders — were attracted to it by its commercial possibilities as the center of a rich farmland and the terminus of the water route. By the 1840's, Brantford was connected by road through Burford to the west with the London-Hamilton road, a less hilly and therefore superior route to that which passed through Paris.

With these advantages, Brantford soon outstripped all other villages in the three counties. Its population of 3,000 warranted incorporation as a town in 1847. Paris, with a population of 2,500, became a town in 1854. Simcoe grew more slowly in the 1840's. It had not the advantage of being on the waterway or on the busiest roads. But its earlier promise was not lost; with a population of about 1,400 it was incorporated as a town in 1850. Brantford in 1877, when it attained a population of 10,000, became a city, and is still the only city in the counties.

The frontier was passing both economically and socially. Simcoe at mid-century had a common school and grammar school; Baptist, Methodist, Congregationalist, Anglican and Presbyterian churches; an active weekly press; a branch of the Gore Bank; and several new industries, including tanneries, a brewery and distillery, a soap and candle factory, and the Van Norman foundry which had been moved there. Architecture began to reflect greater prosperity and new trends and materials. Vittoria had a brickyard as early as 1834, and the patterned brick houses characteristic of Norfolk date from the 1840's. The beautiful large house built by the Sovereign family at Waterford in 1842 shows the classical influence, which was one of the various Victorian styles replacing the earlier Loyalist type.

The greatest event in Haldimand, Norfolk and Brant in the second half of the 19th century was the coming of the railways. They affected both country and town. With their capacity for speed and heavy load and their ability to operate the whole year, they made the canals obsolete and immediately altered the patterns of development.

Some of the villages such as Indiana which had prospered along the Grand River navigation route died when the railways bypassed them and diverted trade. The progress of others like Cayuga, which had looked forward about 1850 to growing into a city, was checked. Mills ceased to run when the company dams were no longer kept in working order. Business at the lake ports also dwindled. They were still used by fishermen and for the import of coal and other bulky commodities, but they were not as before the main outlets for the produce of the interior. The importance of communities on the new railway lines, however, was enhanced.

The Railway Booms of the 1850's and 1870's

The 1850's, the first decade of railway building in Ontario, left Brant in an advantageous position. The Buffalo and Lake Huron railway was completed as far as Brantford in 1854, and finished to Goderich in 1858. Brantford's citizens, disappointed that the Great Western from Niagara Falls to London and Windsor had missed them, initiated a branch to connect with that railway at Harrisburg. It was not until 1905 that Brantford got onto the main line of the Grand Trunk, which by then had absorbed the Great Western and Buffalo-Lake Huron. In the meantime, the Brantford, Norfolk and Port Burwell railway had been sponsored, also to become eventually part of the Grand Trunk. Paris, like Brantford, became a minor railway metropolis. It was reached by the Great Western in 1853, the Buffalo-Lake Huron in 1856, and the Grand Valley electric railway in 1903.

In Haldimand, Dunnville and Caledonia experienced a rise in settlement after the Buffalo-Lake Huron crossed the county in the 1850's. But a network of lines did not appear in

Haldimand and Norfolk until the second period of railway building after Confederation. These included both Canadian and American railways, since the two counties were directly on the route of American roads wanting to shortcut through southern Ontario from Detroit to Buffalo. Completion of Great Western's branch lines was a boon to Simcoe and Delhi in the 1870's, just as the American controlled Canada Southern railway was to Hagersville. Profiting from its position on the Plank Road, and now on a railway, Hagersville was modernized by 1878 to the extent that it had an agricultural implement factory, grist and flour mills and sawmill, all run by steam; a carriage shop; a number of stores; a new two-storey brick school and a new brick hotel.

The age of the railway and of steam was to be short-lived in the three counties as in the rest of the province. They were on the threshold of electric energy and gasoline power. Dunnville and Brantford, in fact, were among the first communities in Canada to have electric lights. And the advent of the automobile, the transport truck and the airplane in the 20th century would take traffic from the railways as rail had done earlier from the canals. The competing lines built in the 19th century would be amalgamated or lopped off. Still, the railways in the transition years gave a new mobility to the people of Haldimand, Norfolk and Brant. They furnished employment for many men in construction and operation and in railway work shops. Even architecture was touched by the railways. Scottish stonemasons, who migrated to work on the Great Western in the 1850's, turned their skills later to the construction of stone buildings. Examples are found in the northern and eastern parts of Norfolk.

Industrial Diversification

Above all, the railways brought in raw materials, facilitated the distribution of goods and promoted industrial development. There was a marked shift in the business community in the late 19th century from primarily commercial interests to industrial. Heavy industries had their beginning. Brantford became famous for its Waterous engines, Victoria stoves, Verity plows, Paterson confectionery, Barber-Ellis stationery and Scarfe paints. By 1900, the flourishing Massey-Harris and Cockshutt firms had made the city one of the world centers of agricultural implement production. In the early 20th century, the company of Goold, Shapley and Muir, which had made bicycles and windmills, moved with the times and began the manufacture of gasoline engines and a high grade of agricultural tractors. The diversity of industry developed at Brantford gave that city the amazing status of third biggest exporter of manufactured goods in Canada on the eve of World War I.

Elsewhere in the counties, there were rising industries lesser in number and magnitude, but still significant. Examples are the Brook Woollen Company, the West and Peachey Foundry, and Innes Canners, all of which would play a lasting part in the economy of Simcoe; or the wagon works, pottery works and Penman textile mills at Paris.

Agricultural Diversification

The rural way of life, too, altered in the era of railway building and industrialization. The farmers, mainly producers previously, were becoming large-scale consumers as well. Homespun clothes were replaced by ready-to-wear; bumpy wagons by well-built carriages; candles by coal-oil lamps; sickles, scythes and flails by mowers, binders and steam threshers. Agricultural societies, fall fairs, breeders, associations, information disseminated by the Ontario Agricultural College at Guelph, and the local example of the two politician-agriculturists in the Brantford district — George Brown at Bow Park Farm and David Christie at Oak Park Farm — all aided in bringing about more scientific husbandry and finer strains of livestock.

Wheat was still widely grown; but farmers, faced by the competition of the western provinces, turned more and more to the growing of barley, oats, corn, vegetables and fruits and to stock raising and dairying. By 1900 mixed farming was the rule in the three counties. Its profitableness was apparent in the number of fine farm houses built in this period, particularly in the sections where the soil and roads were good.

As in the early days, agriculture gave rise to certain industries. Its products were processed in cheese factories, creameries, evaporating and pickling plants, and canneries.

Social Changes

Alexander Graham Bell's successful experiments with telephone calls between Brantford and Mount Pleasant, and Brantford and Paris, in 1876 introduced an exciting means of communication, which further diminished the isolation of rural people as well as facilitating business.

The increase in urban living and removal of some of the drudgery from the farms helped to account both for many references to sports in post-Confederation years and for the increasing achievements of area residents in the creative arts. Popular sports included hockey, baseball, fishing, canoeing on the Grand, lawn bowling, and horse-racing at Simcoe. The Six Nations were highly skilled at lacrosse, a reputation which they still maintain.

Leisure time was used effectively in other ways by Haldimand's Wilson MacDonald; Norfolk's historical artist, W. Edgar Cantelon; Brant's artists, Robert Whale, Paul Wickson and Lawren Harris, and authors, novelist Sara Duncan, short story writer Norman Duncan, and scientific writer Robert Duncan. (None of whom, however, was so widely read as is the contemporary historical novelist, Thomas B. Costain, another Brant native.)

Along with Pauline Johnson and Sara Duncan in literature, the three counties produced a number of women famous in different fields. Abigail Beck showed heroism in rescuing seven men from shipwreck on Long Point. Adelaide Hoodless, born in South Dumfries, founded the Women's Institutes to widen the outlook and knowledge of farm women. Helen Kinnear of Cayuga became the first woman judge in the

province, the first woman to appear as counsel before the Supreme Court of Canada, and the first woman in the Commonwealth to be appointed King's Counsel. Emily Jennings Stowe, born at Mount Pleasant, was the first woman doctor in Ontario and a leading suffragette.

Education and religion continued to be leading interests of the people. By World War I, the counties were well supplied with brick schools and churches and Carnegie public libraries. Norfolk considers Egerton Ryerson, the Chief Superintendent of Ontario schools from 1844 to 1876, one of its most distinguished figures. Haldimand remembers that two of the provincial Ministers of Education, Richard Harcourt and R. A. Pyne, spent part of their lives in that county. Brantford in 1871 was chosen as the site of the Ontario School for the Blind.

Numerous organizations in the counties, such as the YMCA, YWCA, Salvation Army and temperance societies, expressed the rising social concern common to Ontario communities of the late 19th century. Brantford was fortunate in the numbering among its residents of the philanthropist families of John H. Stratford and the Cockshutts, who have made large donations for such purposes as a general hospital, sanitarium, house of refuge, parks and cultural center.

Politics

The people of the three counties have always taken a keen interest in politics. Norfolk twice had as its member the Reform leader, Dr. John Rolph. Haldimand was noted for its political battles, especially the contest of 1851 when William Lyon Mackenzie defeated George Brown in the riding. Brant, after Confederation, returned the Ontario cabinet ministers, E. B. Woods, James Young and A. S. Hardy — the last becoming premier in 1896.

This pattern of being represented by impressive leaders continued into the 20th century with James N. Allan of Haldimand-Norfolk, and Harry C. Nixon, W. C. Good, W. Ross Macdonald, Dr. J. A. Charlton, L. T. Pennell and Robert Nixon of Brant.

The period since 1918, with the adjustments necessitated by two world wars and technological revolution, the stresses of the great depression, and the tensions of the present generation, has presented difficulties for Haldimand, Norfolk and Brant as for their sister counties.

Modern Agriculture

Agriculture has adapted to the new century best of all sectors in the economy, in large part owing to the introduction of flue-cured tobacco in the mid-1920's. The tobacco industry has brought unexpected wealth to the farmers on the sandy soils of Norfolk and southern Brant. It has made business brisk in the tobacco belt towns of Simcoe and Delhi, although at the same time adding elements of rowdiness and problems of seasonal employment. It has also altered radically the ethnic make-up of the counties, for thousands of Belgians, Hollanders, Hungarians, Ukrainians and other European peoples have made their homes in Norfolk and Brant to work in tobacco.

Contributing further to the agricultural prosperity of these two counties are dairying, poultry raising, a big acreage of corn and vegetables, and in Norfolk fine orchards of apples, cherries, peaches, pears and plums, and small fruits. A corollary has been the development of flourishing canning, pickling, jam-making and poultry processing plants at various points. Norfolk is probably the most diversified of all the agricultural counties in Ontario today.

Such a variety in farming and increase in population have not been achieved in Haldimand. It does not have the soil suitable for tobacco or the mildness of climate found nearer Lake Ontario or in Norfolk for fruits. Grain, beef and dairy cattle, and poultry are still the main bases of agriculture in that county.

The Six Nations

One of the distinctive problems of the Grand valley in the last half-century has been the future of the Mohawks. In 1924 the Canadian government replaced the Hereditary Council of chiefs of the Confederacy by an Elective Council. But this solution of the Six Nations government is not likely to be a permanent one. It has never been acceptable to some of the chiefs, and now it is combined with the general question of the advisability of integrating the Indians into Canadian life.

Broadly speaking, there are two social-political groups among the 9000 Indians on the reserve at Ohsweken: the Christian which tends to be European-oriented, and the Longhouse which emphasizes the traditional religion and way of life. The latter claim that the Six Nations are still a sovereign people, and that they want, not integration, but the preservation of their identity in an independent Indian state. This state would maintain close relations with Canada but run its own internal affairs.

Industry

Another problem in the counties has been their failure to fulfill the industrial promise of pre-World War I. They have not competed successfully with the great metropolitan areas of the province, which have had larger labor forces, more capital, bigger markets and better highways. It is true that new industries like Merion Sod in Moulton Township have come in, but often others such as Monarch Knitting at Dunnville have closed down.

Recent signs, however, point to the beginning of a second industrial revolution and urban expansion on a much greater scale than before: the new subdivisions at Simcoe and Brantford; the energetic business and manufacturing sections of Dunnville; the drilling for natural gas in Cayuga and offshore Haldimand; the multimillion dollar generating station of the Ontario Hydro Commission at Nanticoke, and its neighbor, the Steel Company of Canada plant; and the Electric Reduction Company and Sherbrooke Metallurgical Company at Port Maitland. Along with these developments have come the complications of heavier traffic, the need for more housing, servicing and schools, and the hazards of polluted air, water and soil.

It is obvious that the lake, always

influential in the counties' history and now a seaway, has assumed added significance industrially. And the lake is still important for commercial fishing. Port Dover and Port Maitland boast the largest inland freshwater fishing fleets in the world. The fishing industry has been modernized in this century by the use of diesel engines and electric appliances. Freezing processes have made possible a whole new range of Lake Erie fish products.

Tourism

Haldimand, Norfolk and Brant are not a summer resort area so well known as some other parts of Ontario. The Grand River is undeveloped in comparison with, for example, the Rideau waterway. In fact, it has been allowed to lose much of its beauty since the end of the navigation route and the rise of industrialism. Yet the counties are increasingly aware that they have much to offer the tourist all the way from the remarkable Houghton Sandhills on the west, along the extensive park and reforestation areas and sandy beaches beside the lake, to the Grand River Conservation Park and Rock Point Park in the east.

In addition to the many historic spots in the three counties, there are numerous picnic areas and campsites, and facilities for water-skiing, boating and sailing, trout fishing, small-mouth black bass fishing, duck hunting in the Long Point marshes, golfing, and stock-car racing at Cayuga and at Harewood near Jarvis. Moreover, these tourist attractions are easily accessible to persons from both Ontario and the United States. It is to be expected, consequently, that tourism will be one of the expanded industries in the future.

The Present Counties

Haldimand, Norfolk and Brant are proud counties today, conscious of their Loyalist forebears and pioneers from Great Britain and Europe; their road and town builders; their leaders in industry, politics and culture; their men and women who served the nation in war from the days of 1812-14 and 1837 to 1939-45 and the Korean struggle.

Each of the three counties has a strong sense of identity, based on its historic and cultural past and on the pursuits and ambitions of its present residents.

Historical Work of Societies and Governments

Much has been done to perpetuate the counties' history. Canadian and Ontario government boards have marked a number of sites, and federal and provincial centennial grants have been of assistance in local work. County historical societies and museums have been active. Municipalities have shown initiative; an example is the beautiful Carillon Tower at Simcoe, which is one of the most interesting Ontario memorials to the men and women of the two world wars.

But even these efforts have had limitations and uneven success. The Norfolk Historical Society, for instance, bought, but was unable to keep up as a historical center, the century-old Chadwick Academy, a school for boys established in 1829 south of Vittoria.

A great deal remains to be done in the historical analysis of Haldimand, Norfolk and Brant, and there is an urgency to its doing. The three counties are part of an "industrial corridor" in southern Ontario which seems about to enter an age of pervasive and accelerating change. This will tend to obscure or obliterate the historic richness of the past. It is reasonable, then, that a more intensive implementation of existing policies at all levels and the adoption where necessary of new policies should be undertaken quickly in order to protect the area's cultural heritage.

Further Studies and Projects

The following studies and projects are suggested. They are arranged according to the time periods into which the historical background of the counties has been divided.

1) To 1763

Further archaelogical investigations would be useful for knowledge of the native civilizations. It should be possible to make an authentic physical reproduction of a Neutral village from its known resemblance to the palisaded villages of the Hurons. It would be more difficult to reproduce Galinée's cabin on the Black Creek; in this instance an imaginative reproduction based on the information given by Galinée and exact knowledge of the site could be attempted.

2) 1763-1812

Although architectural plans are regrettably lacking for such interesting structures as the government buildings at Charlotteville or Vittoria, there is still a wealth of detail which could be used for an enriched interpretation of the period: Troyer's house and blockhouse, the frame houses of the Loyalists, the plan of the deserted Charlotteville site, old fishing villages, the lakeport of Port Dover, mills which solved the problem of power for the pioneers, the cultural background which the Six Nations brought with them into the valley.

3) The War Years — 1812-14, 1837-38

Places like Burford and Long Point acquired a military tradition in these crises, and families such as the Nelles of Haldimand founded a military reputation. Again, there are historic sites officially unmarked, and many details to draw upon for a more accurate depiction of the area's history. A physical reconstruction of Fort Norfolk would give a sense of historical reality to the whole Charlotteville scheme.

4) 1815-1850

Here, too, there are forgotten people and places; hamlets which dreamed of greatness never to be attained, post offices now closed, churches which are gone with only their cemeteries remain-

ing, broken down "castles" in Seneca township where wealthy immigrants from England lived, the soap-and-candle factory or the Van Norman ironworks whose products met urgent needs of the time, road and canal and town promoters who were as important to their day as the freeway and city planners to the present. Research could place these historic persons and events in a clearer perspective, and could suggest programs of reconstruction — perhaps even the feasibility of reviving the Grand, if not as a commercial waterway, then as a pleasure route.

5) 1850-1914

The re-creation of the more recent past never seems so vital as that of the earlier periods. There have been, however, great changes since 1850 — in railway trains, agricultural machinery, architecture, even in telephones. These changes alone underline the need for programs to preserve the tangible historic records of life since the mid-19th century. And the historian has scarcely touched as yet the careers of most of the clever and fascinating people, such as Helen Kinnear or A. S. Hardy or R. A. Pyne, who lived in the three counties during this era.

6) Since 1914

The greatest need in the contemporary period is the safekeeping of the legacy of the present for the future, whether this legacy is in written documents, the landscape, natural resources, or some other form. For example, the historic mosaic of the counties would be permanently enriched if the Six Nations could conserve their culture, whatever solution for their political and economic status may be adopted; and if the European peoples who have immigrated in recent years could retain some of their distinctive traditions. Studies might help to determine how these ends could be accomplished.

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Rationale

No metallic ore deposits of any significance occur in Haldimand and Norfolk Counties. However, it is the non-metallic geological resources that underpin the economic development of a region. Of particular importance are deposits of building materials and reserves of water. It is no exaggeration to state that without readily available sources of these commodities urban expansion becomes impossible.

Too often in the past, unplanned development around cities has made geological resources impossible to use — either they are built upon or, as in the case of water, polluted.

Economically important deposits, therefore, must be located not simply for the obvious reason that to use a resource it must first be found, but also that urban expansion may be so planned that the natural resources of a region are not rendered unusable.

The Regional Setting

For many practical purposes county boundaries are arbitrary lines that divide a region in an illogical manner. For this reason it is necessary initially to ignore them and to view the geology of the Haldimand-Norfolk Study Area in a larger regional context — that of southern Ontario.

Precambrian rocks with an age of at least one billion years form the basis of this part of the continent. They outcrop north of the unconformity (Figure 2-2) that runs from Georgian Bay to the Thousand Islands. Since these rocks are more than 3000 feet underground in the Haldimand-Norfolk region they are of no economic consequence here. It is worth noting, however, that they formed an old land surface some 600 million years ago, that was slowly flooded by Paleozoic seas, which deposited a variety of marine sediments. The coral reefs, calcareous muds, clays and sands of those ancient waters were ultimately buried, lithified and raised up to become the sedimentary rocks (the limestones, dolomites, shales and sandstones) that are now exposed at the earth's surface in southern Ontario.

For the long stretch of time between Paleozoic and Quaternary eras, the rocks of southern Ontario were weathered and eroded so that debris from them was transported elsewhere to form new sediment. During this vast interval the region was only peripherally affected by the great geological revolutions that were taking place in other parts of the continent. For example, the Algonquin Arch that runs down the center of southern Ontario like a backbone, was a marginal effect of the forces that helped to produce the Appalachian Mountains.

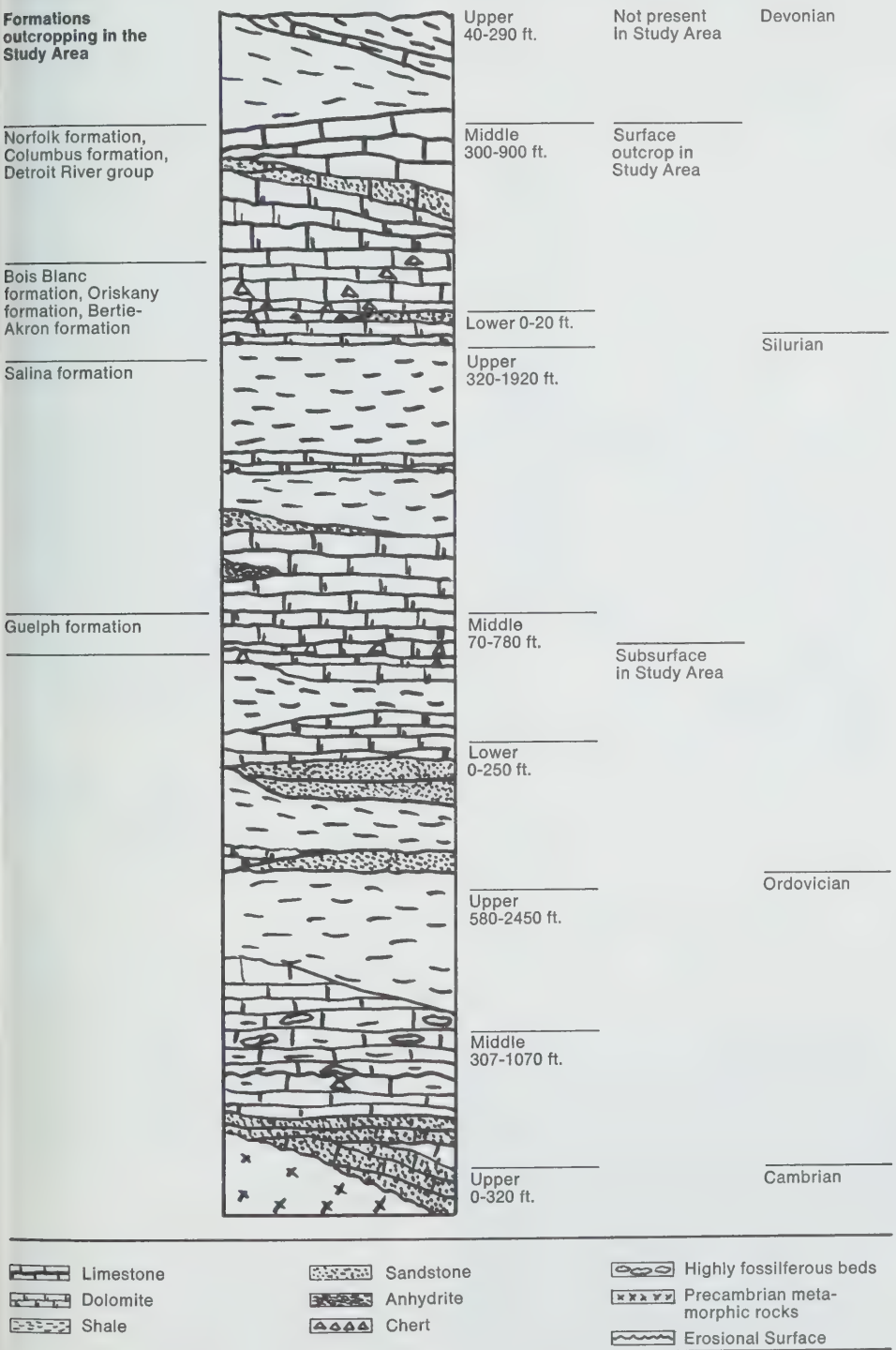
It was in this long time span that a significant element of the Ontario landscape came into being — the cuesta. This is defined as a gently sloping plain bounded on one side by an abrupt escarpment. In Ontario the most obvious one is that which is bounded by the Niagara ridge. But less obvious ridges, following the strike slope of several Paleozoic formations, divide southern Ontario into a layer-cake of superimposed cuestas. Most of the Haldimand-Norfolk area is a cuesta terminated on the north by the edge of the Bois Blanc formation, and modified by radical and comparatively rapid changes that occurred in the last million years.

The agent of these changes was the gigantic ice sheet, of continental proportions, that pushed down through what is now Ontario in four major advances in the Pleistocene period. The ice, which in the Haldimand-Norfolk area came from a lobe emanating from Lakes Ontario and Erie, scraped and gouged the bedrock, pushed loose deposits into ridges, and in melting left behind the surficial material that now blankets most of the area.

The face of the land in this part of the world, then was shaped by forces that acted from Paleozoic to Pleistocene times. Even now wind, water and frost are at work modifying further the landscape that was more than half a billion years in the making.

Bedrock Geology of Southwestern Ontario

Figure 2-1/Stratigraphic Column



The geological formations of this part of Ontario are shown in Figure 2-1 which indicates those that outcrop in Haldimand and Norfolk Counties.

The general outcrop pattern in southern Ontario is shown in Figure 2-2, which also indicates the two-county Study Area. The bedrock geology of the area is shown in more detail on Map 2-1.

Description of Outcropping Formations

An itemized description is given below of all the formations that outcrop in the Study Area, and that therefore have real or potential economic significance in Haldimand and Norfolk Counties. The descriptions begin with the oldest and proceed to increasingly younger formations.

Guelph Formation
A grey, cream, buff or brown dolomite with individual beds up to 6 feet thick. The rock is fine to coarsely crystalline. Its porous nature makes it the principal reservoir rock for the natural gas deposits of the Study Area. The dolomite contains numerous bands of fissile, argillaceous material, and also a number of sulphide segregations similar to the important ores of the Mississippi valley. However, the sphalerite and galena segregations in the Study Area are too small to be workable.

Salina Formation
Alternating brown, fine grained, dense dolomite (in places bituminous) with grey dolomitic shale. A seven-fold division of the formation is made — beds A through G (Figure 2-5). Beds A, B, D and F contain evaporite deposits associated in places with pinnacle reefs. The evaporites are typical of those that are deposited first in an evaporite sequence, namely, anhydrite and gypsum. This accords with their position at the edge of a basin of deposition (the Michigan Basin). They are the only deposits of their kind in Ontario and are a major resource for the construction industry.

Bertie-Akron Formation
Brown, cream and bluish grey dense dolomite. Contains bands of argillaceous dolomite and rare bituminous streaks. It is a major source of crushed stone in Haldimand County.

Oriskany Formation
Outcrops in only a small area in the vicinity of Hagersville. The rock is a quartz sandstone with a calcareous matrix. Bituminous and iron stains are common. Formerly dimension stone was quarried from this formation though now it is no longer worked. The upper

Figure 2-2/Bedrock Geology of Southern Ontario with an Outline of the Study Area

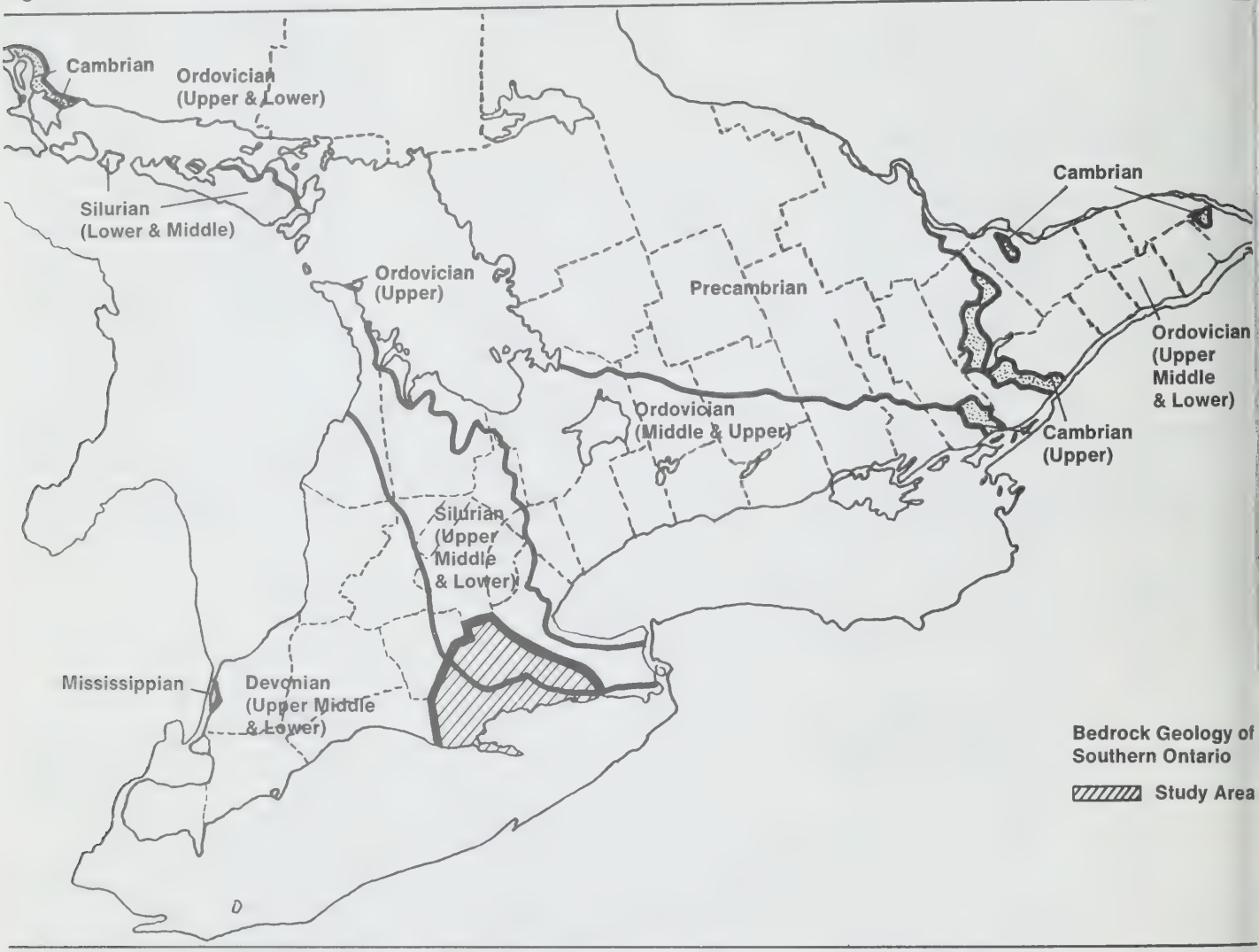


Figure 2-3/Silurian dolomites of the Guelph formation are exposed in the Dunnville area where surficial deposits are relatively thin. The rocks are fossiliferous, well-bedded and contain sulphide segregations in places.

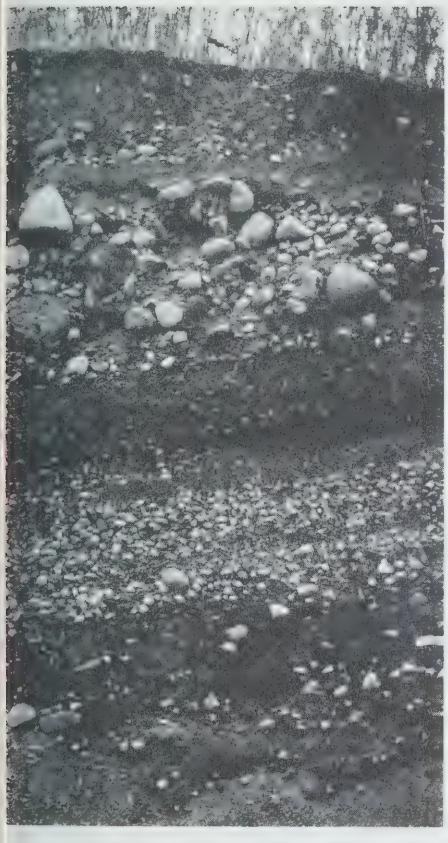


Figure 2-4/Outwash gravels of economic importance near Windham Centre are a very poorly sorted mixture of rocks, sand and silt, laid down by meltwaters rushing down from the wasting Pleistocene ice-sheet.

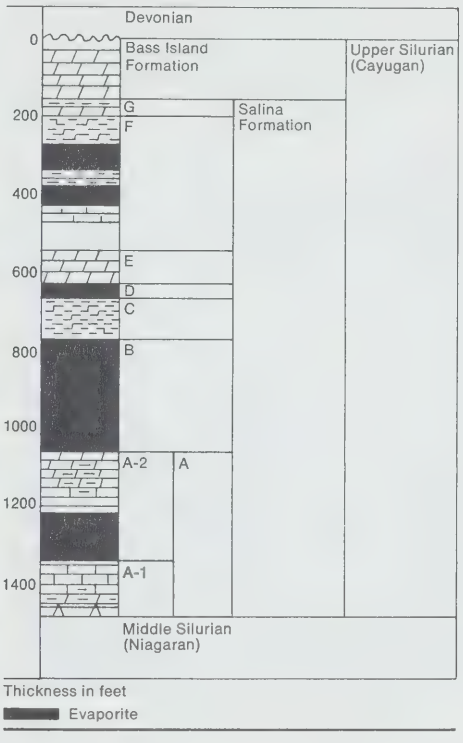
and lower boundaries of the formation are disconformities.

Bois Blanc Formation
Brownish grey, thin to medium bedded limestone of intermediate crystallinity. The upper and lower parts of the formation are cherty with a relatively chert-free zone in between. Like the Bertie-Akron formation this rock is a major source of crushed stone in Haldimand County. In some places a sandstone occurs as the basal member.

Detroit River Group
Brownish and bluish grey limestone and dolomite. Contains thin argillaceous beds. The group pinches out in Norfolk County between Norwich and Lake Erie. Of little or no economic significance.

Columbus Formation
This sandy limestone has been recognized at depth in gas and oil wells in

Figure 2-5/Divisions of the Salina Formation (Sandford, 1965)
The evaporite is gypsum and anhydrite in the study area, though further west it is dominantly halite.



Norfolk County. It does not outcrop and therefore has no economic significance.

Norfolk Formation or Dundee Formation
The youngest bedrock formation of the Study Area is a light brown, medium grained limestone. Chert occurs in lenses and nodules. Of no economic significance.

One other bedrock feature that may conveniently be presented here is the shape of the bedrock surface. On Map 2-2 it has been contoured at 20-foot intervals.

The most prominent feature is the partially buried ridge marking the beginning of the Devonian. From the ridge the bedrock slopes gradually down to the shore of Lake Erie. The general structure is that of a cuesta.

The Pleistocene deposits laid down during and after the Wisconsinian glaciation in southwestern Ontario are shown on Map 2-3. Their main economic significance is to the construction industry as many glacial and glaciofluvial landforms contain usable deposits of gravel, sand and clay. For convenience, the deposits are divided into three kinds below.

Ice-contact Deposits
These include moraines, kames, eskers and drumlins. The principal agent in shaping them as landforms was the ice itself though meltwater at the leading edge of the glacier, as well as beneath it, played a role in the imperfect sorting of the gravels contained in kames and eskers. Moraines are the earliest features to appear above the melting ice and are composed of relatively impermeable tills made up of unsorted clays and silts. The tills are calcareous and generally stony and have no intrinsic economic value. When overlain by permeable material, however, as in the northwest section of Norfolk County they support the water table. Around the moraines meltwater has deposited some minor and discontinuous kamey gravels. No eskers are recognized in the Study Area and the so-called drumlins of Haldimand County are of no economic significance.

Meltwater Deposits
Melting and retreat of the ice provided waters that flowed in spillway channels between the morainic highlands. In the channels in Brant County and the northern part of Norfolk County, well rounded gravels were deposited and their exploitation forms one of the principal industries of the Paris area. Meltwater flowing in the channels fed and constructed a sandy delta that now underlies the Norfolk Sand Plain. This is an almost inexhaustible sand deposit though the clayey nature of some of the deposits may limit its usefulness to the construction industry. It may, however, have limited potential as a molding sand.

Lacustrine Deposits
In the Study Area, the meltwaters flowed into a lake that was a precursor of Lake

Figure 2-6/Swamps are common in the Study Area where impervious surface formations are found. This example at Dry Lake is underlain by lacustrine clays of the Haldimand clay plain.

Erie. The various shore lines of this lake are marked at the present day by sand hills in Norfolk County (e.g. those of Houghton). These are good silica sands that may be of use to the glass industry. The main drawback is that the reserve is rather small. Haldimand County was originally beneath the waters of the precursor of Lake Erie. Consequently it is underlain by a very extensive deposit of lacustrine clay. None of the clay is worked though it is potentially useful for the manufacture of bricks.

The total thickness of Pleistocene deposits is shown on Map 2-4. In the east the drift is about 50 feet thick or less. In the west it is more than 300 feet thick. Because of this, exploitation of bedrock resources is restricted to the region to the east of Woodhouse Township.

There are, of course, deposits younger than Pleistocene to be found in the area. These are the soils, peat and muck of the swamps, and the alluvium (bottom land) found along river channels. These are all clearly delineated on the maps prepared for Chapter 7, Agricultural Land Use. The only geological feature younger than Pleistocene that will be specifically dealt with here is the present Lake Erie shoreline.

Erosional Pattern

The Lake Erie shoreline is still emerging since the area is still recovering from the load of super-incumbent ice that buried this region in Wisconsinian times. The fundamental pattern of the shoreline is a series of scallops with neighboring scallops being separated from each other by sand spits. The largest of the sand spits is Long Point in the westernmost part of the Study Area. East of it is the arcuate scallop, locally modified, that forms the shoreline of the rest of Norfolk and all of Haldimand Counties.

Both elements of shoreline, scallops and spits alike, result from the action of longshore currents and any understanding of the process of erosion along the shore must begin with a consideration of the nature of these currents.

Figure 2-7 is a simplified model showing the basic pattern of water movement in this part of Lake Erie. The main flow is roughly west to east toward the Niagara River, which provides an outlet into Lake Ontario. Associated with the main current, and essentially formed from it by drag along the shore and near-shore lake-bottom, are a number of eddies moving in a counter-clockwise direction. The eddies and sub-eddies, arising by local modification, are the major forces working to alter the Lake Erie shore.

From Figure 2-7 it can be seen that where the currents first come into contact with the shore, destructive processes dominate and erosional wearing away is generally rapid. Thus the highest recorded rate of erosion in the region is on the western boundary of Norfolk County where the shore is being cut away about 14 feet a year. Where the eddy cell has spent its energy, deposition takes place and constructional (or depositional) features of the landscape predominate. This happens for example along the inner shore of Long Point, where the longshore current, with its sedimentary load, meets the outflow from Inner Bay, also bearing sediment. The two currents are neutralized and sediment is deposited in the bay and along the point.

An observation that would not be

Figure 2-7/Erosional Pattern Along the Lake Erie Shoreline

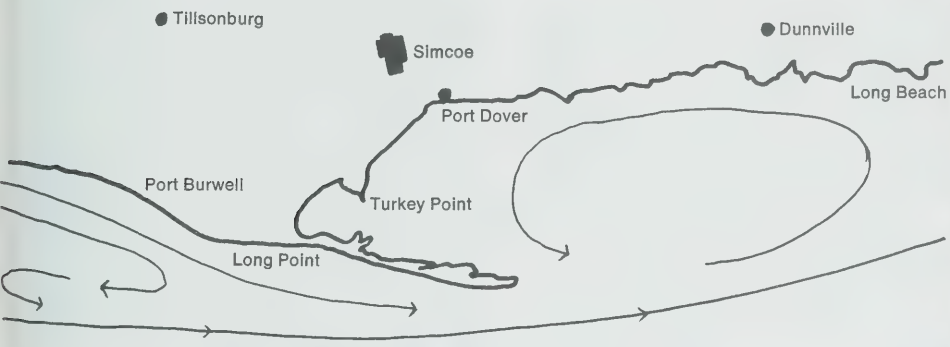


Figure 2-8/Turkey Point is an example of a shoreline separated from the mainland by a marsh underlain by lake or bay — bottom silts possibly exposed by isostatic rebound after the Pleistocene ice-sheet melted. Type IA and IIA.

out of place here is that constructive and destructive features of the landscape go hand-in-hand, so that, to use a well-known illustration, there would be no Toronto Island without the erosion of Scarborough Bluffs. The former is built by material provided by the destruction of the latter. In other words, in the area under study, Long Point, which began forming when the shores of glacial Lake Warren became coincident with those of Lake Erie about 4000 or 5000 years ago, is fed by material eroded from the shoreline further to the east. This is an important point for landscape conservationists to bear in mind: preventing erosion at one place will cause problems in the area of deposition associated with it. There is a delicate balance in the landscape similar to the one found in an ecosystem.

A further point worth making is that Inner Bay is gradually and naturally silting up. The process cannot be reversed except by taking drastic measures, the consequences of which may be worse in the long run than the silting problem itself. Thus it has been suggested that the problem might be alleviated by diverting Big Creek to a former outlet opening directly into Lake Erie. Such a procedure, changing as it will the flow regime on both sides of Long Point, could have disastrous consequences for the Point. A more reasonable approach to the problem would be to impose sound soil conservation practices along Big Creek, thereby cutting to a minimum the sedimentary load carried into the bay. In the long term, however, the problem is intractable because the bay is a part of a shoreline undergoing glacial rebound so that it will inevitably become dry land unless unforseen disasters intervene.

The scallop and spit model is of course a gross one and must be refined to fit more closely the natural state found along the shores of Haldimand and Norfolk Counties. The simple model holds more closely in the west than in the east. In the west the easily eroded Norfolk Sand Plain provided and still provides the material for the construction of Turkey and Long Points. These two points are growing together and will presumably form a bar across the bay mouth at some time in the future. This

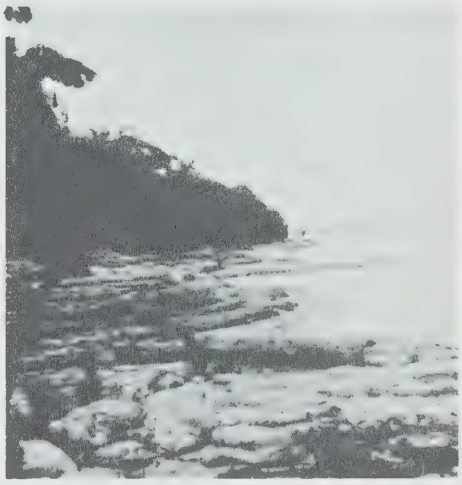


Figure 2-9/This low profile shoreline near Port Maitland is predominantly of sand and rock. Surficial deposits in this area are shallow so that bedrock outcrops are common. Type IIIB.

will act as a dam to Inner Bay and could conceivably lead to the complete silting up of that body of water. Again an analogy with Lake Ontario is apt. The sand bar across Hamilton Bay grew from material dropped by longshore currents as they were checked by waters flowing out of the bay. A similar situation exists in Norfolk County where water flows out of Inner Bay and is checked by, and in turn checks, the longshore current in the lake. This leads to the deposition of the sedimentary load carried by the currents which causes the simultaneous formation of the points and the silting up of Inner Bay.

The Haldimand shoreline represents a more highly modified version of the scallop pattern, the modifications themselves being minor scallops possibly arising from local variations in the longshore currents in response to bedrock outcrops along the coast. Thus the spits bounding these minor scallops all have a bedrock base.

A Working Classification of the Shoreline

Map 2-5 indicates the main features of the Lake Erie shoreline in the Study Area. The features described have in general arrived at a stage of development beyond which they should not change very much in size or form during the next few generations, although the

Table 2-1. A Shoreline Classification for the Study Area

Dominant Feature	*Types*
1. Elongated, sandy bodies of low relief. Essentially parallel to trend of lake-bottom contours. Marshy area lies between these bodies and mainland.	A. Barrier Spit. Multiple ridges, parallel to shore of mainland. Zones of swamp and vegetation along inner edge. Anchored to mainland at one end. B. Bay Spit. Anchored to mainland, growing across bay mouth. Not parallel to mainland shoreline.
2. Swampy areas of very low relief, consist of silty sediments, possibly exposed by glacial rebound.	A. Type found landward of types 1A and 1B above. B. Type found along mainland shore of bay.
3. Low-profile shoreline dominantly of sand or clay.	A. Dominantly sand, with marshy area inland. B. Dominantly clay, possibly with foreshore of other materials (sand, gravel, bedrock).
4. Bluffs. Steep bank, dominantly of sand or clay. Gravel common in some bluffs.	A. Sandy bank with bank height in excess of 20 feet above water level. B. Clay bank, bank height same order as above.

Figure 2-10/Precipitous bluffs at Port Burwell formed by eroding longshore currents moving from west to east. Type IVA.

location of the shoreline may be displaced considerably. However, human activity can exercise a large local influence, and any major change is likely to be man's doing.

Quite obviously, this classification is of a descriptive nature. A classification based on the engineering characteristics of the materials would be most desirable but would require data that are not available at the present. Furthermore, retreat of the bluffs is possibly the most pressing erosional problem along the lakeshore, and to understand this process a study of the dominant factors effecting it would need to be undertaken. These would include wave action, surface runoff, groundwater seepage, ice and frost action, and slumping.

Practical Consequences

The primary consequence of this pattern of erosion in Lake Erie is that the shoreline is receding inland in the scallops and being built out into the lake along the spits. In practical terms this means that the inner portions of the scallops are hazardous places in which to build permanent structures such as buildings, roads, powerlines and other services. This is borne out by measured erosion rates along the shore (Map 2-5).

It is noteworthy that the steepest and most unstable slopes occur along the Norfolk County shore where the predominant surficial material is the incoherent sand of the Norfolk sand plain. It is also noteworthy that along the Norfolk County shore there is as a rule a considerable depth to the surficial material. This fact and the lack of coherence in the sand makes the region generally unsuitable for the siting of heavy foundations.

By contrast, the Haldimand clay plain forms a shoreline of generally low profile, though steep slopes do exist, notably in lots 6 to 13 of Sherbrooke Township. A further contrast is that the bedrock is comparatively close to the surface along the Haldimand shore making this county a much more suitable place to site heavy foundations.

An environmental hazard that must be guarded against along the shore is the possibility of oil seepage from the

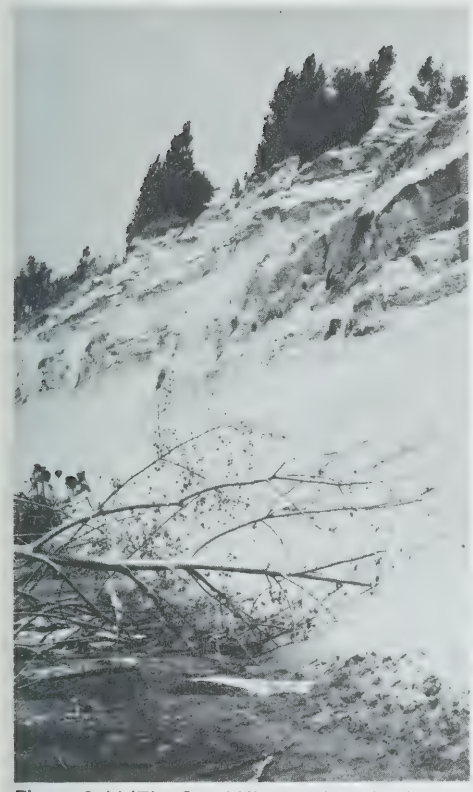


Figure 2-11/The Sand Hills on the lakeshore in Norfolk County are a spectacular landform 140 to 160 feet high. They are created by wind-driven sand and are endangered by erosion from human use. Type IVA.

offshore natural gas wells (see Map 2-6). Because of this hazard, drilling is no longer allowed offshore in the Lake St. Clair region further to the west.

A final point concerns recreational facilities. The great predominance of sand as a surficial material in the west provides that part of the region with many good beaches. There are also a number of small beaches in Haldimand County. Strip development along the Erie shore has essentially removed much of this land from the public domain. Much that remains as park land open to the public (*e.g.*, parts of Turkey and Long Points) cannot be fully developed in a recreational sense without destroying the value of these regions as conservation areas. Consequently, as the population of the area increases shortage of recreational facilities will become more and more acute.

Table 2-2. Mineral Production, 1968

	Number of producers	Quantity (tons)	Value (dollars)
Gypsum	2	570,715	1,461,189
Crushed stone	6	2,023,612	2,021,907
Sand and gravel	4	261,045	224,657
			3,707,753

Natural Gas Production

		Number of producing wells	Quantity (m.c.f.)
Haldimand	— offshore	104	916,694
	— land	642	358,121
Norfolk	— offshore	25	422,386
	— land	514	1,394,282
			3,091,483

The geological resources produced in the Study Area are gypsum, crushed stone, sand and gravel, and natural gas. All the gypsum produced in the province of Ontario, and 25 percent of the province's natural gas come from this region. The latest mineral production figures (kindly provided by G. R. Guillet of the Ontario Department of Mines) appear in Table 2-2. Map 2-7 illustrates the location of building materials in the Study Area.

For convenience the geological resources of the area will be dealt with under two headings — bedrock resources and surficial resources.

The principal resources taken from the bedrock are gypsum, stone and natural gas.

Gypsum

Gypsum occurs in the Salina formation in beds up to 12 feet thick. These are the only such deposits worked in Ontario though similar beds are found in the Moose River basin in northern Ontario. The principal users of gypsum are the construction companies. They use it in the production of plaster, wallboard, and as a retarder in Portland cement. There are two producing mines, both in Haldimand County:

1) Domtar Construction Materials Ltd.
Half a mile north of Caledonia on the north bank of the Grand River.

2) Canadian Gypsum Company Ltd.
Three miles north of Hagersville, west side of Highway 6. Con. 3 and 4, Oneida Twp.

Stone

Dimension stone was at one time taken from this area though only crushed stone is produced now. Crushed stone is used mainly in road construction, concrete aggregate and railway ballast. The main producers are listed below:

1) Dunnville Quarries Ltd.
Half a mile south of Byng. Lot 17, Con. 1, Dunn Twp.
Bertie-Akron dolomite.

2) Cayuga Quarries Ltd.
Three and a half miles west of Cayuga, north side of Highway 3.

Lots 45 and 46 on 1 North,
N. Cayuga Twp.
Bertie-Akron dolomite quarried,
beneath a 5-foot cap of
Bois Blanc limestone.
3) Haldimand Quarries and Construction Ltd.
Eastern outskirts of Hagersville.
Lots 27 and 28 of Con. 1, Oneida Twp.
Bois Blanc limestone and Bertie-Akron dolomite.
4) Steetley Industries Ltd. (formerly Canada Crushed and Cut Stone Ltd.)
Lots 13 and 14, Con. 13, Walpole Twp.
near Hagersville.
Bois Blanc limestone.
5) Dufferin Materials and Construction Ltd.
(formerly Hagersville Quarries Ltd.)
Lot 13, Con. 13, Walpole Twp.
Bois Blanc limestone.
6) Norfolk Quarry Company, Port Dover.
Lot 13 or 14, Con. 2, Woodhouse Twp.
Norfolk Formation, limestone.

The formations exploited by the above producers are, therefore, Bois Blanc, Bertie-Akron and Norfolk. All of these are inferior to the Guelph formation as they contain numerous shale interlayers. In addition, the Bois Blanc and Norfolk rocks contain a high percentage of chert, which is chemically undesirable in limestone used in the manufacture of cement.

Natural Gas

The two large producing gas fields in the region are the Haldimand Field and the Norfolk and Elgin East Field. Their general outlines can be seen from the density of points on Map 2-6, which shows all the gas wells in the area. This is the most thoroughly documented of the geological resources of the region and all core-logs are on file at the Department of the Environment in Toronto. Natural gas is likely to play an ever-decreasing role in the economy of the region since its only possibility of expansion lies in offshore production, and it appears probable that legislation will be enacted to forbid offshore drilling. As noted above, such legislation is already in force in the Lake St. Clair region. Between 1966 and 1968 the number of producing wells diminished from 1336 to 1285 and the amount of natural gas produced fell by just under 15 percent.

Figure 2-12/The high profile, predominantly clay, shoreline at the mouth of Young's Creek differs from the sand bluffs with steep slopes covered with vegetation. Type IVB.

Other Resources

The Silurian formations contain several showings of sphalerite (zinc sulphide), galena (lead sulphide), and fluorite (calcium fluorite). Zinc and lead are obtained from the two sulphide ores elsewhere in the province. Fluorite was mined in central Ontario for use as a flux in the steel, glass and enamelling industries. None of the Haldimand-Norfolk showings are economically workable.

Surficial Resources

In economic terms the most important surficial resources are sand and gravel, clay and groundwater. Groundwater is dealt with in Chapter 5, Water Resources. All that will be said here is that the Norfolk sand plain forms the most extensive aquifer in the Study Area.

Sand and Gravel

The sand resources of Norfolk County are immense. The sand plain is approximately 1000 square miles in extent and the deposit is generally about 30 feet deep. Most of it is underlain by boulder clay and therefore forms a good aquifer. Indeed, the water contained in the deposit is to some extent the limiting factor in quarrying operations, since the water table is generally not more than 15 or 20 feet below the surface.

The main use of sand and gravel is in the mixing of concrete. None of the sand is sufficiently free of clay or carbonates to be usable in glass manufacture. Some of the Lake Warren beach sands may be pure enough for such a use but reserves are comparatively low. The main producers are listed below.

1) Cayuga Quarries Ltd.
One mile northwest of Simcoe on Lot 3, Con. 13, Windham Twp. The deposit is worked to the water table which is encountered at a depth of 15 feet. The deposit is probably deltaic, and consists of 80 to 85 percent sand and 15 to 20 percent gravel.

2) Cookson Construction Ltd.
Lot 4, Con. 3, Woodhouse Twp. Worked to water table at 12-foot depth. The deposit is a glacio-fluvial outwash one, made up of 80 percent sand and 20 percent gravel.

3) G. I. Nichols Gravel Supply
Mr. Nichols operates three pits in beach gravels alongside the Paris Moraine. First pit — Lot 18, Con. 9, Windham Twp., 8-foot face, 4 feet are 95 percent stone, 4 feet are 80 percent sand. Second pit — Lot 22, Con. 11, Windham Twp., 10-foot face, 80 percent sand, 20 percent stone. Third pit — Lot 2, Con. 1, Windham Twp., worked as required.

4) Township of Townsend Pit
Lot 8, Con. 12, Townsend Twp. Beach deposit on west side of Galt Moraine. 15-foot face, 70 percent gravel, 30 percent sand.

5) Robertson Sand and Gravel Ltd.
Lots 2 and 3, Con. 8, Townsend Twp. 15 to 20 feet thick outwash deposit, 70 to 75 percent sand.

Clay

The clay resources of Haldimand County are even greater than the sand resources of Norfolk County. The deposit is generally about 50 feet deep. The clay, which is suitable for the manufacture of tile and brick, is not worked in Haldimand County. An extension of the Haldimand clay plain into Brant County provides raw material for several brick and tile manufacturers in that area.

Summary and Recommendations

1) The most important and extensive geological resources of the two-county area are natural gas, and the materials of the construction industry — stone, sand, clay and gypsum. Of these, clay is not yet worked. Gravel reserves are low, but large deposits are close at hand in the Paris region of Brant County. The stone, sand and clay deposits are virtually inexhaustible, with the main problems of exploitation being encountered with the bedrock. The Bois Blanc and Norfolk formations contain chert bands and nodules, which may not be desirable chemically and possibly also from the point of view of crushing. In addition, the two formations named, and the third formation quarried in the area (Bertie-Akron), contain too many shale bands for the rock to be generally used in the production of lime and cement. The bedrock in these three formations is much less pure on average than the Guelph formation which has fewer chert and shale bands.

2) Except in the southeastern corner of Norfolk County, surficial deposits are too thick to allow bedrock quarrying to be a feasible operation in this county.

3) The thickness and nature of overburden has important consequences for the siting of heavy foundations. Most of Norfolk County is covered by a thick layer of surficial material, much of it relatively unstable and incoherent sand. On the whole, this county is a less favorable place to locate heavy industry than Haldimand County, where the overburden is compartively thin and may be economically stripped away. The incoherent nature of the Norfolk sand also presents conservation problems, particularly along the creeks. Poor land use practices can cause a rapid increase in erosion along stream banks and ultimately increase the sedimentary load entering Inner Bay. However, the sandy overburden in Norfolk County is not solely a liability. As an aquifer it is a considerable asset, and one that will become increasingly important as the water needs of the area increase.

4) Turkey and Long Points are the main

conservation areas of the region. They cannot be fully developed as mass recreational facilities without destroying their nature. Since the material of which they are constructed is derived to a large extent from the sand bluffs to the east, any attempts to conserve the shoreline in the vicinity of the bluffs are likely to have destructive consequences, in the long run, for the points themselves. Aside from Turkey and Long Points, the most favorable places to develop beaches as mass recreation facilities, are in those regions where the Norfolk sand plain abuts the lake.

5) There are a number of real or potential hazards to the environment in the region. One of the most obvious arises from the pattern of erosion along the Lake Erie shoreline. In the central regions of the scallops the shoreline is receding an average of 2 to 6 feet per year. Already some roads and services in Haldimand County have had to be relocated and presumably this will happen again. Another shoreline, that of glacial Lake Warren, which runs across the middle of Norfolk County, also poses problems for the few private houses that are built on it. This is especially noticeable in Windham Township where highway cuts through the old beach deposits have led to fairly rapid erosion of the adjacent properties.

Gas wells provide another potential hazard in the area, especially the offshore ones, which could lead to pollution problems in the lake and along the shoreline. Furthermore a number of older, defunct wells on shore have never been capped and no longer have owners on record. Presumably it will be left to the developers to cap these wells.

One final environmental hazard worthy of mention here is the possibility of thermal pollution in Lake Erie when Haldimand County becomes more industrially developed. Both the Nanticoke power station and the projected steel plant will use large quantities of water for cooling. The return of this water to the lake will tend to raise the lake's temperature. Some study of the effects of this on the natural environment is needed.

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Introduction

The atmosphere is not only an important natural resource but also an occasional source of discomfort or of economic loss. Many human activities are affected directly or indirectly by the weather; "climate" is quite naturally included in most lists of location factors for regional planning. A method for actually incorporating meteorological parameters into a regional plan, however, is not well established. Frequently, in fact, published documents give only token recognition to the atmosphere. Climatic statistics of temperature, humidity, wind, rainfall and sunshine are presented in conventional form for only a single "representative" station. The summaries fail to provide any information on regional variations — the central theme in planning.

There has been little dialogue between meteorologists and regional planners. The meteorologist has not been providing, and the planner has not been requesting, the most meaningful climatic statistics. Routine climatic summaries available from national weather services are often too general to be useful in specific instances. Knowledge of the prevailing wind direction is of little value in seeking solutions to air pollution problems, for example. Often in an area of 5000 square miles or so, there may at best be only one or two weather stations with complete hourly observing programs. To study regional variations, data from networks of voluntary climatic stations must be used. The data are limited to twice daily observations of temperature and/or precipitation; there are no measurements of important elements such as humidity, wind and radiation. Moreover, the period of record may be short or broken in some instances. The meteorologist therefore is reluctant to rely on such sources of information. Another difficulty is that historical data cannot always be used as direct predictors of future climate. Regional planning implies that the face of the earth is to be changed, which in turn implies that local climate is to be modified. When a large city replaces open country, for example, almost all of the meteorological elements are affected. Finally, "climate" is a difficult word to define. Each human activity has its own set of relevant climatic elements and critical values; the civil engineer's preception of climate, for example, is quite different from a farmer's or an air pollution control officer's.

These difficulties challenge the meteorologist to develop new methods of integrating climatic information into regional planning studies. This chapter is a research study, rather than an application of standard techniques to a particular region. An approach is proposed and developed, permitting climate to be examined as a location factor in the Haldimand-Norfolk area for industrial, residential, agricultural and recreational use.

This paper is written for non-specialists in meteorology; technical discussions are avoided or inserted as appendices. A few essential terms such as "temperature inversion" are defined in Appendix A.

Classification of Meteorological Processes According to Size

Weather systems are classified according to size: *macro* (large), *meso* (medium) and *micro* (small).

Macrometeorology is the study of the high- and low-pressure areas with horizontal dimensions of 1000 miles or so, whose signatures are to be seen in satellite cloud photographs and whose motions can often be followed across continents.

Mesometeorology is the study of weather processes of the size of one or a few counties. Included in this class are valley winds, lake breezes and urban circulations. These patterns are most strongly developed when regional winds are light and skies are clear.

Micrometeorology is the study of small weather features such as those in a forest clearing, around a building or over a small lake. Sometimes the temperature changes within a few feet of a solid surface are very great.

The following proposition is offered as a rational basis for examining climate as a location factor. Weather patterns that match in size the area of a few counties are mesometeorological in origin. This intermediate dimension is therefore of primary importance for regional planning. Macrometeorological systems are too large to produce regional differences when averaged over many years, except insofar as they are modified by mesometeorological influences. Micrometeorological processes, on the other hand, are too small to be usefully considered: the erection of a building modifies the local climate significantly, and a microclimatic analysis of an entire region would be impractical.

Climatic average values tend to obscure mesometeorological factors. Some researchers, considering this difficulty, have suggested that a meaningful interpretation may be obtained by separating the data in advance according to various macrometeorological patterns, discarding all cases of unsettled weather.[1] Mesometeorological features can then be identified and interpreted physically.

Figure 3-1/Cold Air Flow Across a Warm Lake

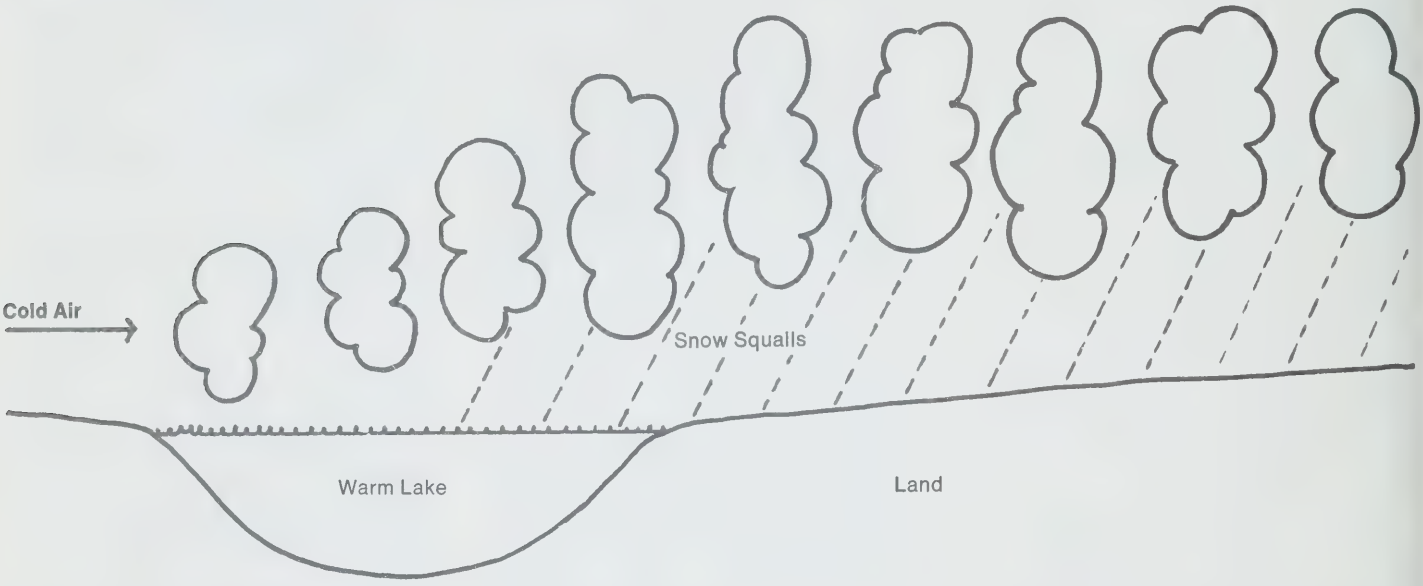
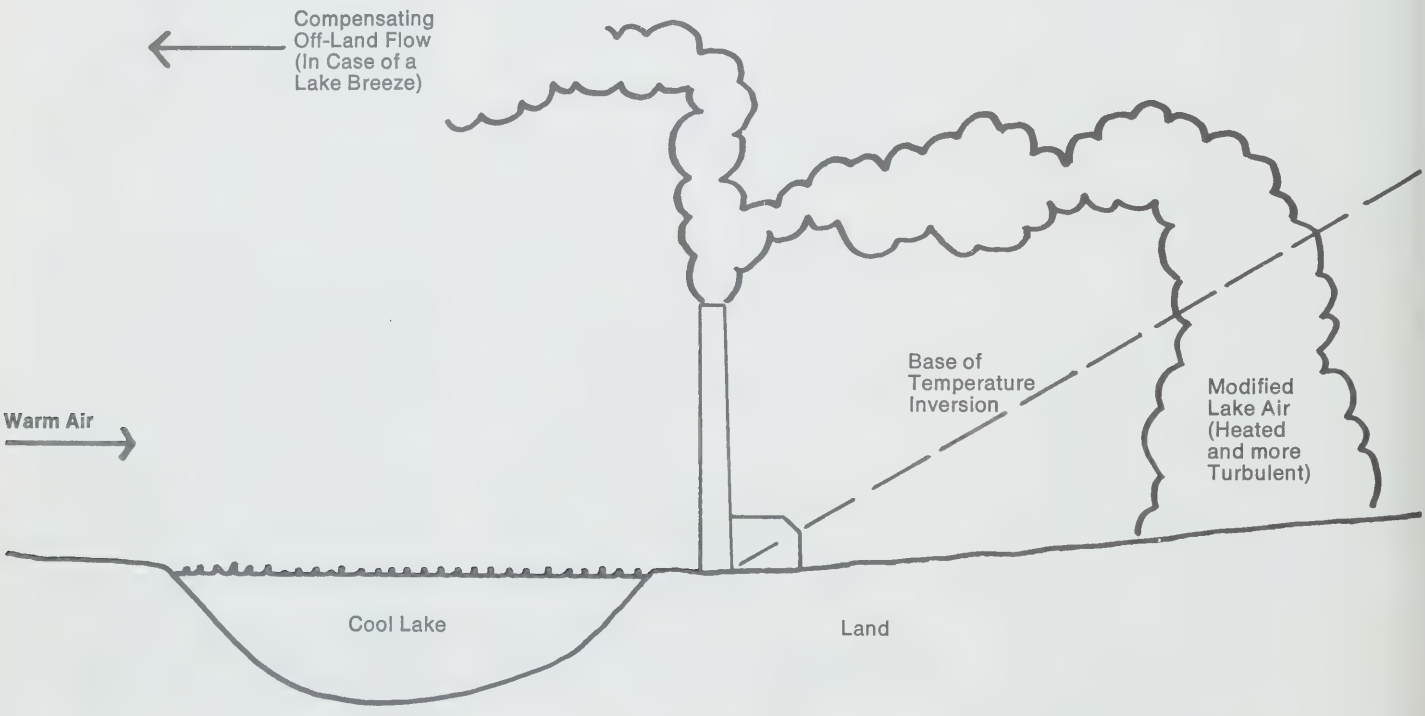


Figure 3-2/Warm Air Flow Across a Cool Lake



Irregularities in the surface of the earth produce spatial differences in heat and moisture balances, generate winds, and cause the climate to vary from place to place. Continental weather patterns, for example, are created by temperature and moisture gradients between equator and pole, and between land and sea.

Surface features that might be expected to produce significant mesometeorological variations in the Haldimand-Norfolk area include the Great Lakes, river valleys, towns, and regional (not local) variations in soil type and ground cover.

The mesoclimate of the Study Area will be described and explained; then climatic location factors will be developed. First, however, it is appropriate to describe in general terms the relevant mesometeorological processes.

Table 3-1/Average Changes in Climatic Elements Caused by Urbanization[1]

Element	Comparison with Rural Environment
Contaminants	
Condensation nuclei	10 times more
Particulate gaseous admixtures	5 to 25 times more
Cloudiness	
Cover	5 to 10% more
Fog, winter	100%
Fog, summer	30% more
Precipitation	
Totals	5 to 10% more
Snowfall	5% less
Relative humidity	
Winter	2% less
Summer	3% less
Radiation	
Global	15 to 20% less
Ultraviolet, winter	30% less
Ultraviolet, summer	5% less
Sunshine duration	5 to 15% less
Temperature	
Annual mean	1.0 to 1.5°F more
Winter minima (average)	2 to 4°F more
Heating degree days	10% less
Wind speed	
Annual mean	20 to 30% less
Extreme gusts	10 to 20% less
Calms	5 to 20% more

[1]Landsberg 1962.

The Great Lakes

The Great Lakes are warmer than the surrounding land in winter and colder in summer. This produces a number of weather effects.

1) Winter snowfall and cloudiness anomalies are pronounced around the Great Lakes. Heavy snow squalls develop when cold air moves across open water (see Figure 3-1). Because outbreaks of arctic air usually occur with northwest winds, however, the principal snowbelts in southern Ontario are along the shores of Lake Huron and Georgian Bay. When lake-induced snow is falling heavily in Goderich, Collingwood and Buffalo, skies are often clear in Simcoe. Nevertheless, cold air sometimes moves in a wide arc from the Canadian prairies, arriving in Haldimand-Norfolk from the southwest after crossing Lake Erie, and causing snow squalls. Local snowfalls can be quite substantial on occasion.

When a low-pressure area moves across or just south of Ontario, snow sometimes blankets the entire region. In this case, the modifying effect of Lake Erie is often sufficient to melt the snow within a few miles of the north shore.

2) Summer rainfall and cloudiness anomalies are noticeable around the Great Lakes. Daytime showers are damped over the cool water and within a few miles inland, but nighttime fog and low clouds are more prevalent over the lakes.

3) When regional winds are southerly and relatively warm in all seasons, the surface air is cooled by the water, creating a *temperature inversion* over Lake Erie (*i.e.,* the temperature at a height of several hundred feet is higher than than it is at a height of 5-10 feet — see Figure 3-2. This creates an unfavorable condition for the dispersal of air pollution — see page 47).

4) In spring and summer, when skies are clear, lake breezes may develop even when regional winds are moderately strong from land to water. The off-water flow begins several hours after sunrise in a narrow coastal strip but penetrates farther and farther inland during the afternoon. The temperature structure illustrated in Figure 3-2 occurs in this case too, but there is a compensating off-land flow at a height of 2000 feet or so. Near the ground, the cooling influence of the lake air disappears a few miles inland.

River Valleys

The valleys in the Study Area are not deep enough to generate well developed valley wind circulations, *i.e.,* upslope breezes in the day and downslope drainage at night. However, small river beds can have two important influences on local climate. In the first place, they provide preferred channels for inland intrusion of lake breezes. This effect has been demonstrated in the cases of the Rouge and Humber river basins in Metropolitan Toronto.[2] Secondly, the channels are probably sufficient to permit modest air drainage at night. This stirs the air and inhibits the formation of radiation frost in the river valleys.

Towns

Urban areas have a distinctive climate caused by the addition of manmade heat

Sources of Data

Method of Analysis

and pollution sources, and by replacement of open land by buildings and pavement. Some of the urban effects are listed in Table 3-1; these are average figures, which may be greatly exceeded on individual occasions. A characteristic "heat island" develops, temperatures in the built-up area being several degrees higher than in rural areas. The temperature differential is sometimes sufficient to generate a local wind circulation when regional winds are light, the downtown area acting as a chimney with inflow from all directions. Around an industrial area, too, a closed circulation may develop as illustrated in Figure 3-3, bringing the heated gases to ground level in a closed loop that is several miles wide.[3] Even a small settlement or a single factory chimney can produce a "heat island" effect.[4]

Regional Variations in Soil Type and Ground Cover

The surface is an important factor in regulating local climate. Because soils vary widely in heat and water storage capacities and in *albedo* (the fraction of sunlight that is reflected and scattered by the surface), the local atmospheric heat and water balances vary also. Over dry sandy soils, for example, temperatures are higher during the day and lower at night than they are over moist surfaces, and this may generate or modify wind flows. Similarly, the climate is different in and above a forest from that over farmland.

In attempting to relate soil type and ground cover to mesometeorology, only the major regional variations need to be considered, and the effects of an individual woodlot or ploughed field can be neglected. Examination of the physiography of the Haldimand-Norfolk Study Area reveals two principal soil types:
1) a sand plain, relatively light in texture and color, covering most of Norfolk County and extending northward into part of Brant County;
2) a clay plain, relatively heavy in texture, dark in color and moist, over most of Haldimand County.

There are two principal types of weather observations:
1) hourly measurements of a large number of elements, such as temperature, humidity, wind and cloudiness, at first-order stations;
2) twice daily measurements of maximum and minium temperature and of precipitation at both first-order and at cooperative second-order stations.

In addition, special measurements for particular purposes are made at agricultural research stations and elsewhere (radiation, soil temperature, etc.).

The Meteorological Service of Canada acts as a central repository for climatic data. The observations are placed on punched cards and are given a number of quality controls to remove obvious inconsistencies and arithmetic errors.

In the Study Area at the present time, Simcoe is the only first-order station and, in particular, the only source of hourly wind observations. Although anemometers have been operated from time to time at a few other locations, *e.g.,* at the Dunnville RCAF Station and the Port Burwell tobacco-fleck field site, the data have not been used in this study because regional patterns can be revealed only by analysis of concurrent observations. For example, any attempt to compare winds at Dunnville measured in 1940-44 with winds at Simcoe in 1960-64 is confounded by both space and time variation.

There are about 35 stations in and near the Study Area providing twice daily observations of temperature and/or precipitation. The locations are shown in the maps to follow (see, for example, Figure 3-4). This network has proven to be satisfactory for mesometeorological analysis.

Finally, there are a few stations that measure the number of hours of sunshine. These include Delhi and Kohler in the Study Area, and Woodstock, London Airport and Vineland in adjacent counties.

The general features of the climate of southern Ontario have been described in a recent paper and will not be included in this report.[5]

Climatological

The World Meteorological Organization recommends that 30 years of observations be used to compute climatic averages. The period 1931-60 has been designated as a standard. Because the frequencies of various macrometeorological weather patterns vary from year to year, average values of the various climatic elements obtained from five to ten years of records may not be representative of long-term conditions.

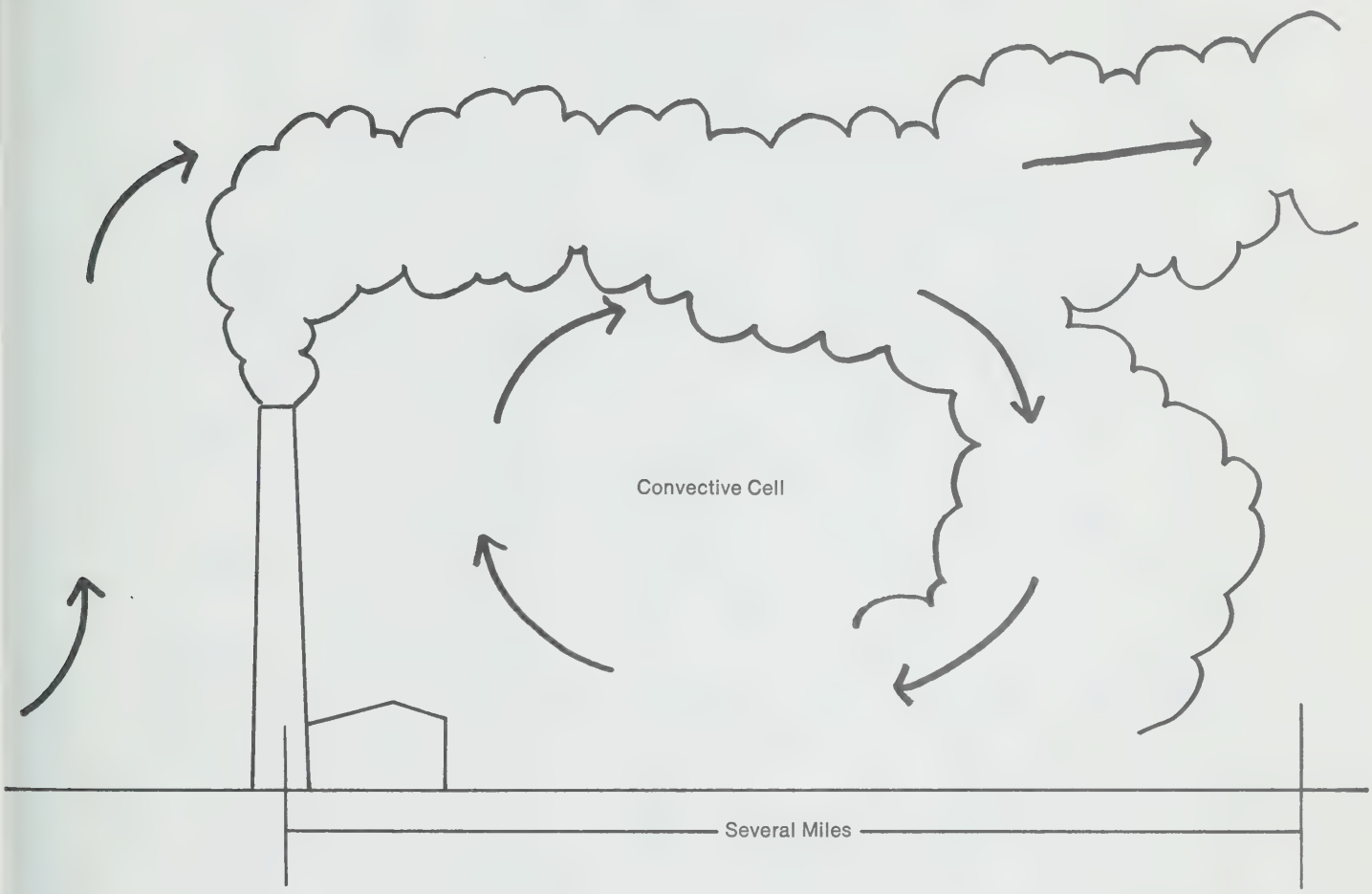
This study is based mainly on only a three-year period of data (1965-67). There are several reasons for this.
1) Because the analysis is to be related to regional planning, there is no need to determine the average temperature at a single location with great accuracy. Of more importance is the temperature difference between adjacent stations.
2) Although land use in the area has changed little over the last 30 years, a trend in climatic values may nevertheless have occurred. Data from a recent period (1965-67) is most likely to represent regional patterns as they exist today.
3) The network of voluntary weather observing stations is constantly changing. Because the method of analysis requires concurrent data, a decision to use only three years of records greatly increases the number of locations available for study.
4) In the analysis of maximum and minimum temperatures, the data have been subdivided into groups, each of which is associated with a particular macrometeorological pattern. Variations in the annual frequencies of these patterns, a principal cause of climatic trends and cycles, is not a consideration in the analysis.

The data for the three-year period were transferred from punched cards to magnetic tape. All subsequent operations were then performed on a UNIVAC 1108 computer. The criteria used to classify the temperature data into various sub-groups of days were as follows.

Sky Condition

The sunshine observations at Delhi were examined. For maximum temperature analysis, all days with less than five

Figure 3-3/Thermal Convection Cell Generated by Hot Chimney Gases



hours of bright sunshine were rejected. In the case of minimum temperature, instances were excluded in which there were less than five hours of bright sunshine on the previous day as well as on the day of observation. These criteria reduced the sample size, but eliminated most cases of unsettled weather. Undoubtedly on a few occasions, skies were sunny at Delhi but cloudy in other parts of the Study Area. The remaining samples of data were large, however, and subsequent analysis confirmed that the main mesometeorological patterns were revealed.

Regional Wind

In order to obtain regional wind criteria that were independent of lake breezes and other local winds, the Buffalo balloon observations at a pressure level of 850 millibars (a height of approximately 5000 feet) were examined. The days not rejected because of cloudiness where subdivided according to Buffalo 850-mb wind direction into two groups: off-land (west through north to east: 261° to 079°), and off-water (east through to west: 080° to 260°). A further subdivision was made according to whether the Buffalo 850-mb wind speed was greater or less than 11 mph. The Buffalo balloon observations are taken only twice daily, at 7:00 a.m. and 7:00 p.m. EST. For minimum temperature classification, therefore, the computer was programmed to examine the 850-mb wind for 7:00 p.m. of the previous day and for 7:00 a.m. of the day of observation. If the two winds were sufficiently different to produce a different classification, *e.g.,* if the 7:00 p.m. wind were northerly and the 7:00 a.m. wind southerly, the day was discarded thereby ensuring that the remaining cases represented steady conditions. Similarly, the winds for 7:00 a.m. and 7:00 p.m. of the day of observation were used as criteria for the maximum temperature.

Season

A study of land and lake average temperatures indicated that relationships could be sharpened by using only two seasons: a cold period (September-February, inclusive) and a warm one (April-August, inclusive). For the temperature analyses, therefore, observations from March were not used. The resulting number of groups was 16

Figure 3-4/Daytime Summer Maximum-Temperature Differences from Simcoe Values, Regional Winds off the Water and Stronger than Average, Sunny, 97 Cases. Simcoe Average Maximum: 74.6 Degree Fahrenheit.

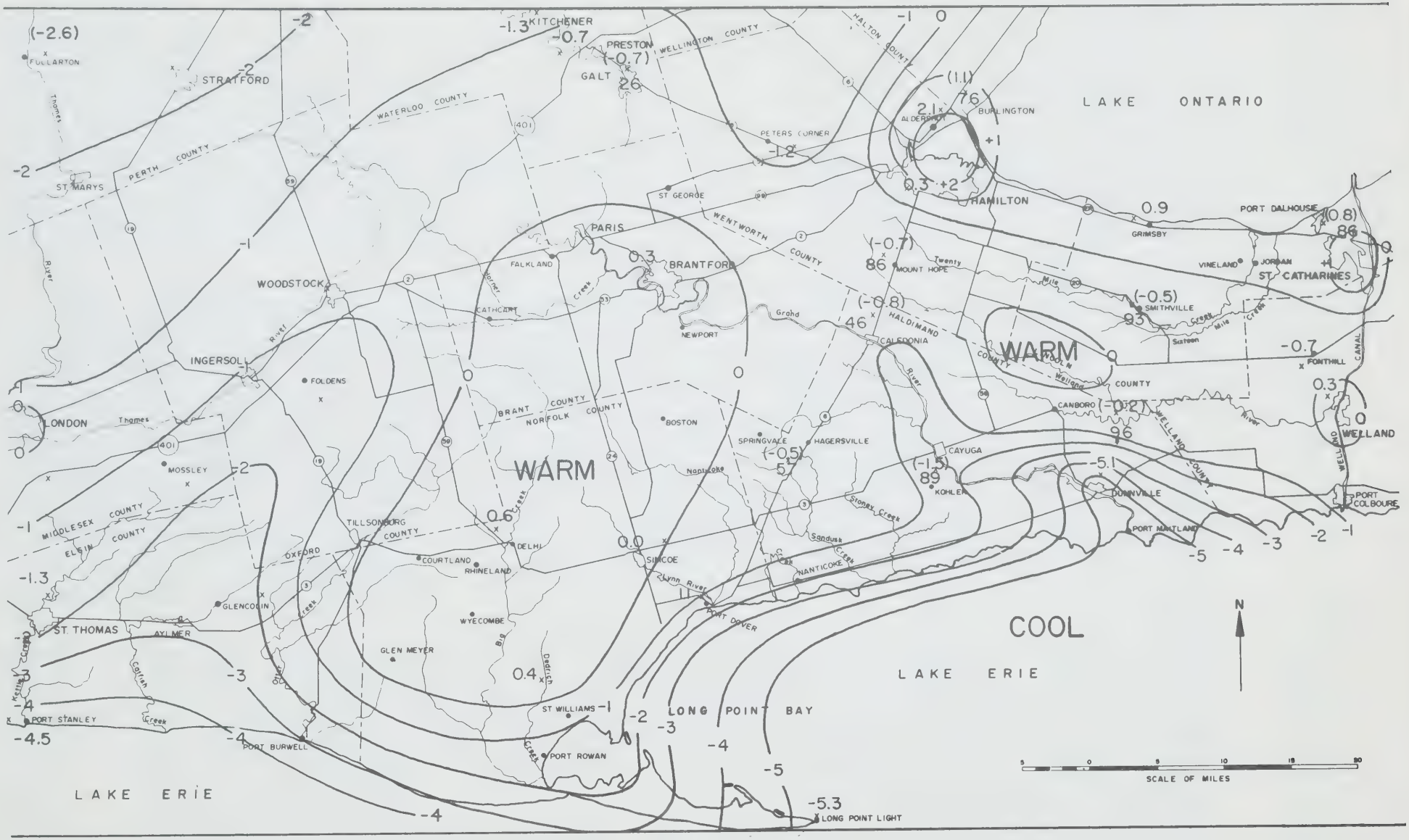


Figure 3-5/Daytime Summer Maximum-Temperature Differences from Simcoe Values, Winds off the Land and Stronger than Average, Sunny, 159 Cases. Simcoe Average Maximum: 71.6 Degree Fahrenheit.

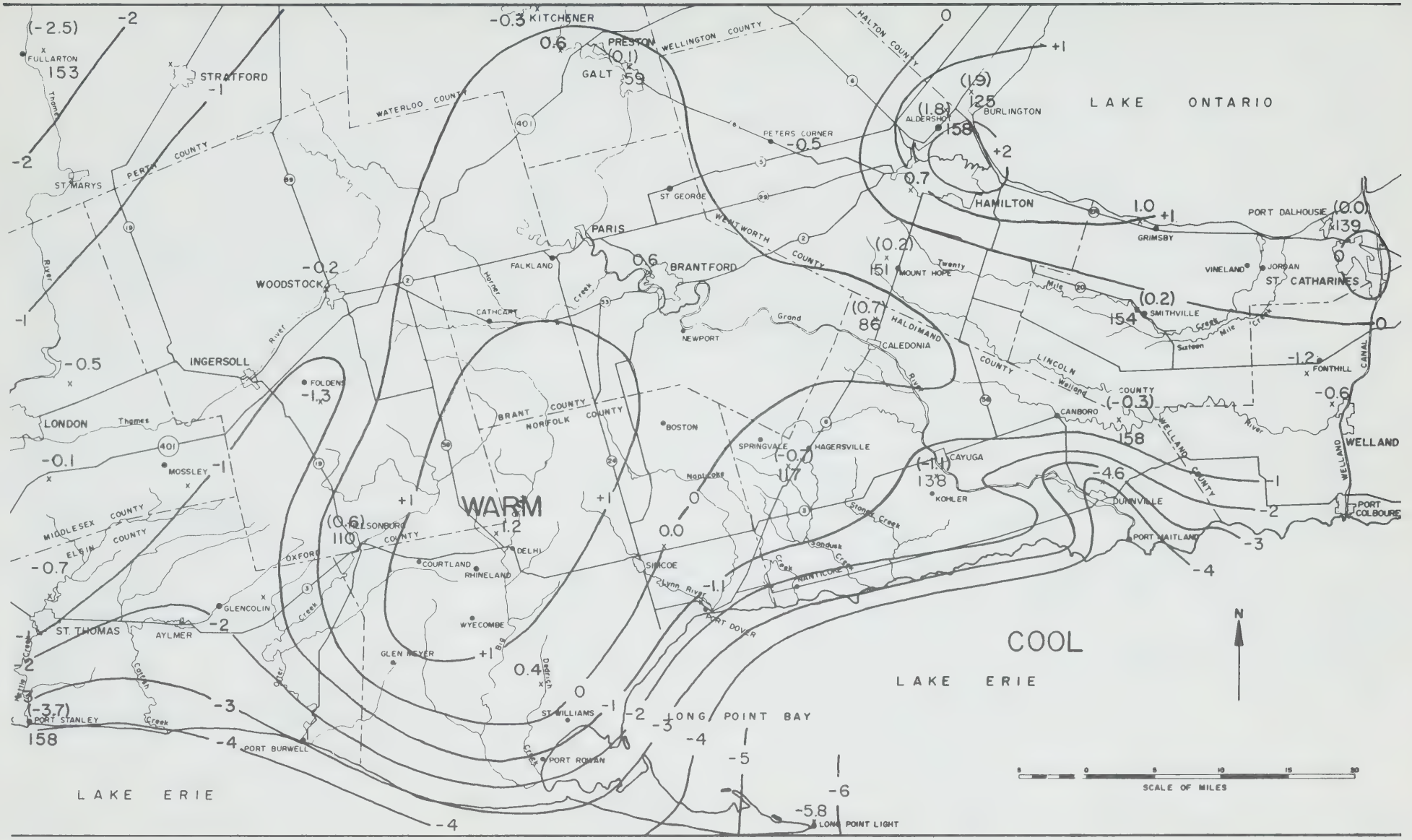


Figure 3-6/Daytime 'Winter' Maximum-Temperature Differences from Simcoe Values, Winds off the Water and Stronger than Average, Sunny, 72 Cases. Simcoe Average Maximum: 47.7 Degrees Fahrenheit.

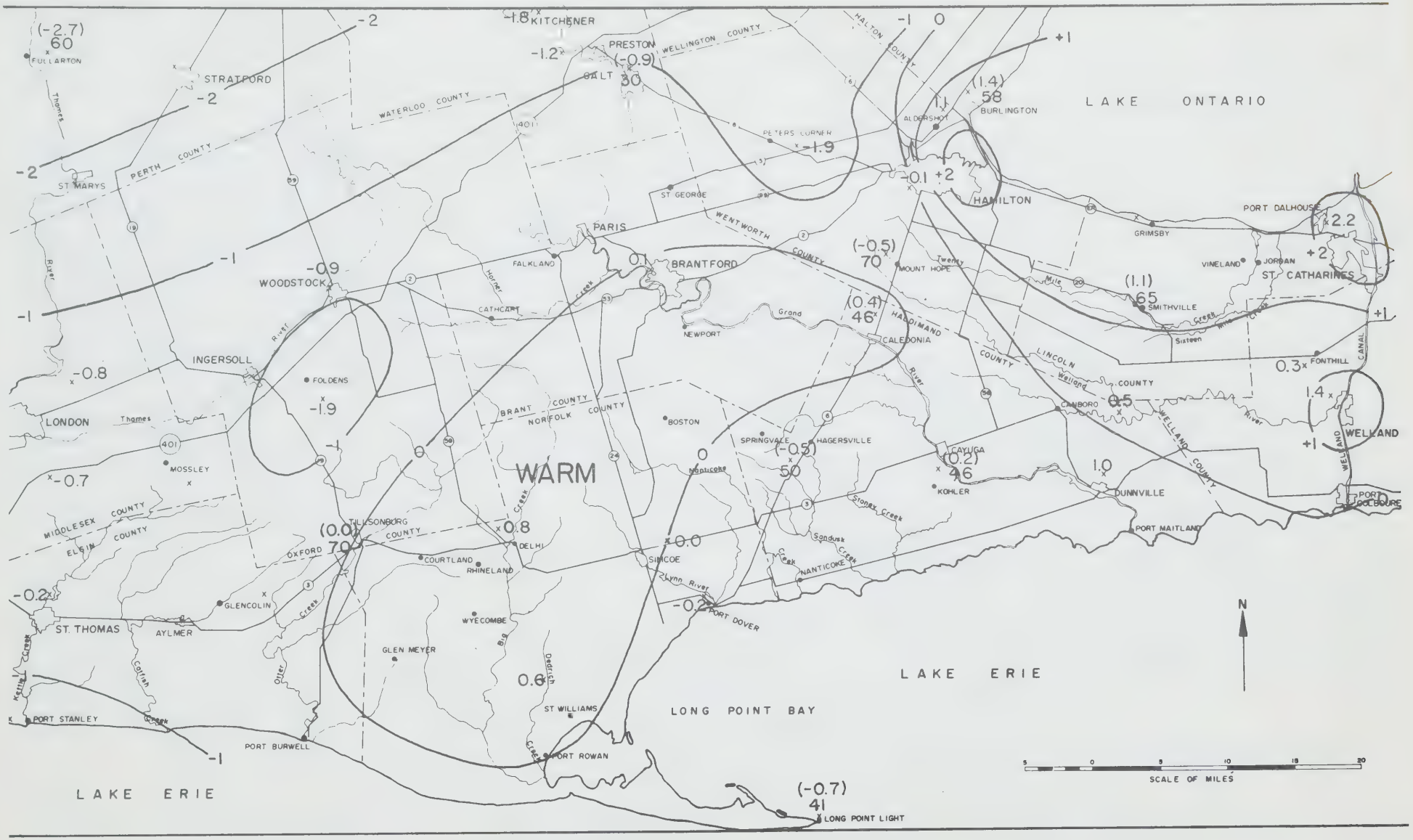


Figure 3-77 Nighttime Summer Minimum-Temperature Differences from Simcoe Values, Winds off the Water and Stronger than Average, Clear, 95 Cases. Simcoe Average Minimum: 55.4 Degrees Fahrenheit.

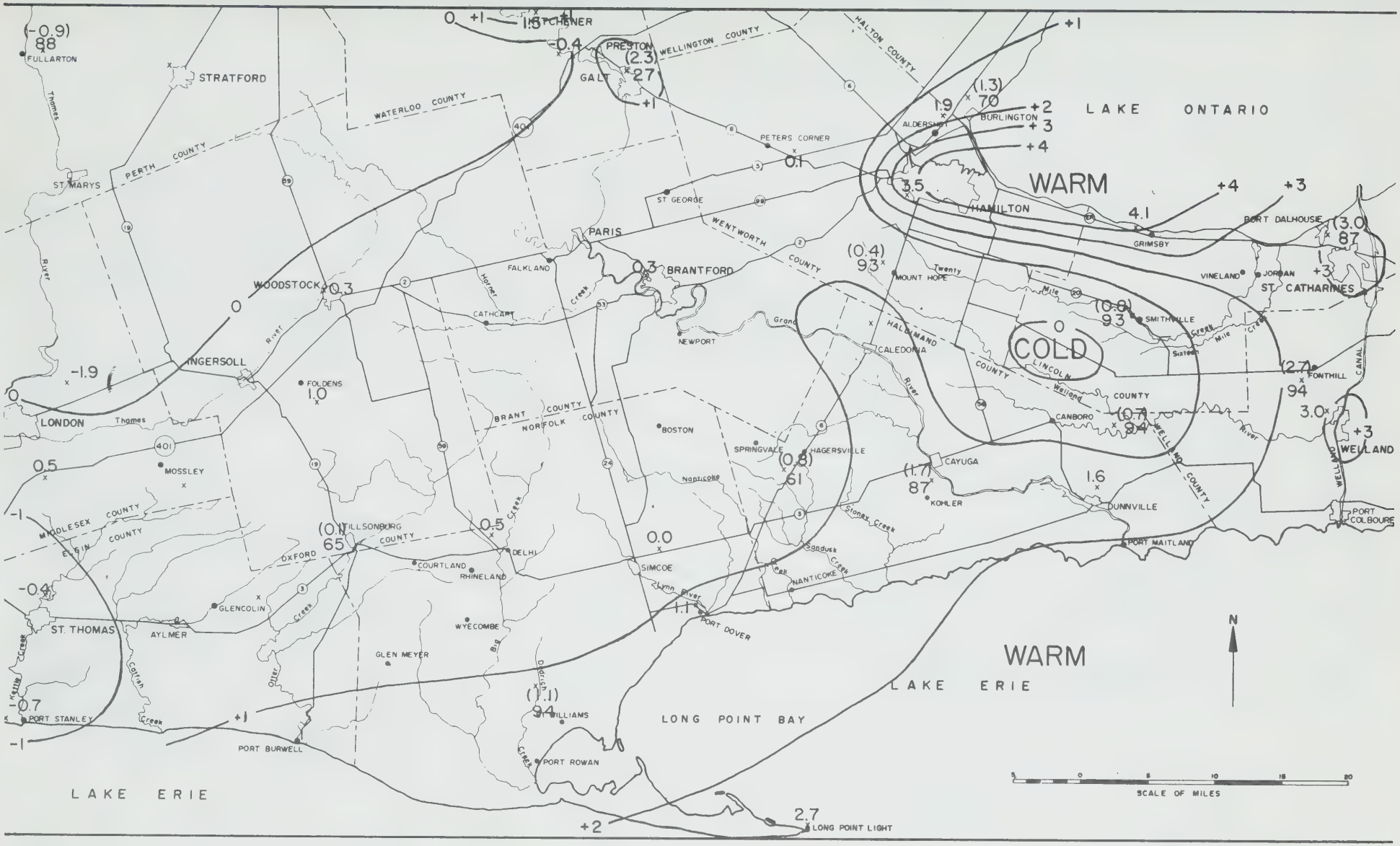


Figure 3-8/Nighttime Summer Minimum-Temperature Differences from Simcoe Values, Winds off the Land and Stronger than Average, Clear, 104 Cases. Simcoe Average Minimum: 46.6 Degrees Fahrenheit.

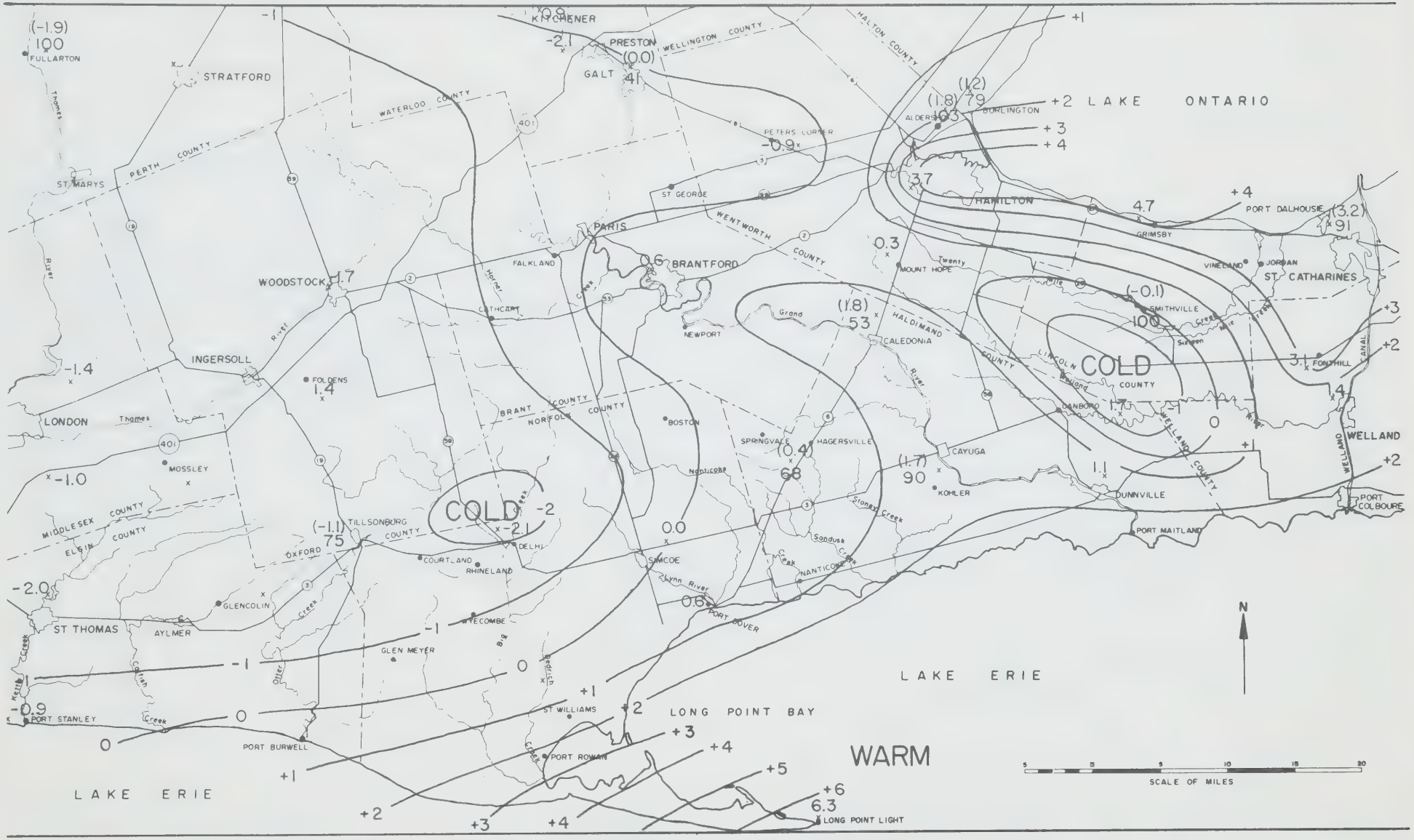


Figure 3-9/Nighttime 'Winter' Minimum-Temperature Differences from Simcoe Values, Winds off the Land and Stronger than Average, Clear, 89 Cases. Average Minimum: 26.3 Degrees Fahrenheit.

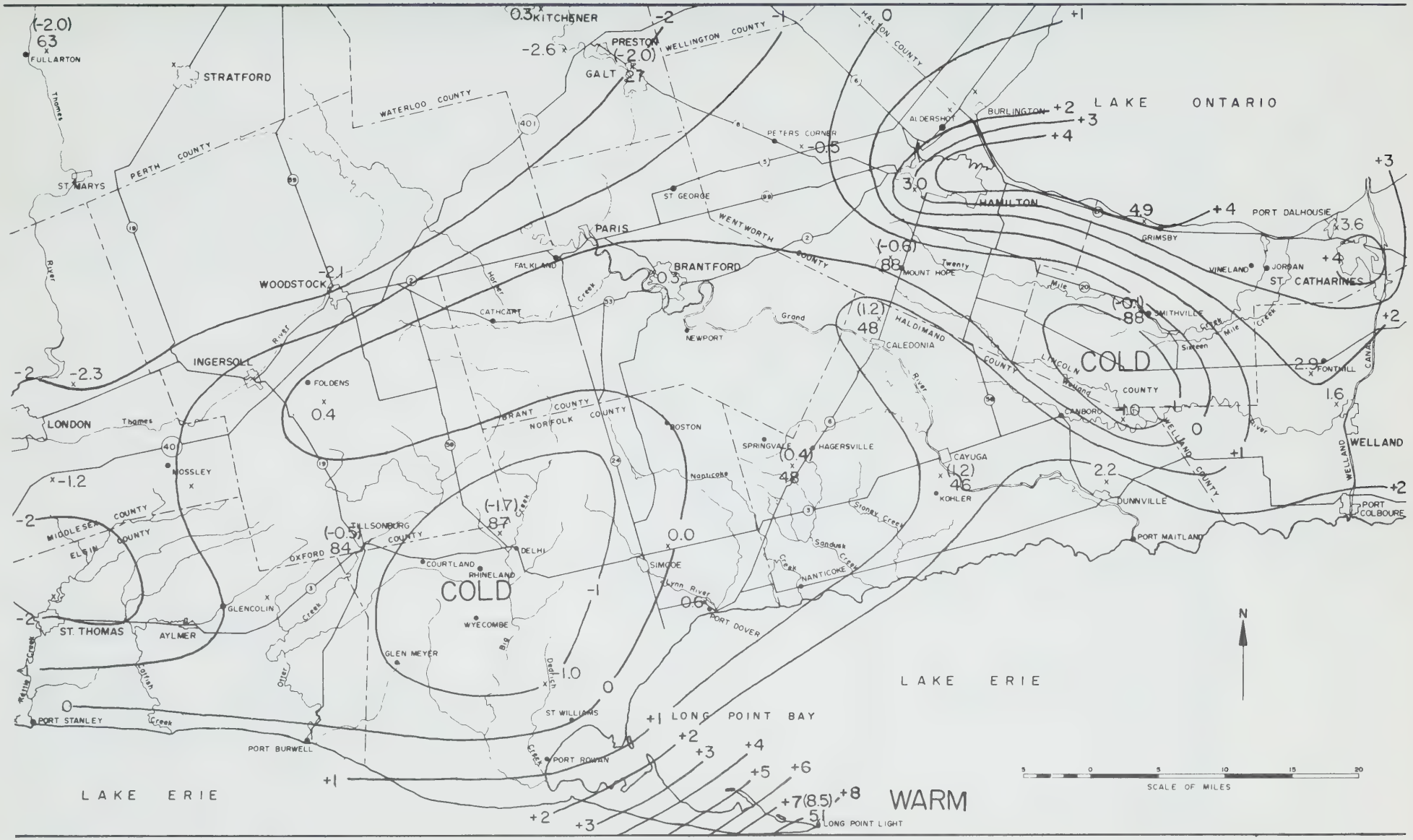


Table 3-2/Comparison of 3-year (1965-67) with 30-year (1931-60) Climatic Averages.

Station	Averaging Period (years)	Maximum Temp. June-Sept. (°F)	Minimum Temp. Dec.-Feb. (°F)	Annual Snowfall (inches)	Monthly Rainfall May-Aug. (inches)
Delhi	3	76.7	19.0	45.5	2.6
	30	77.7	17.8	57.1	3.1
Caledonia	3	74.7	18.7	45.6	2.1
	30	77.4	17.0	43.9	2.7
Brantford	3	75.9	20.2	48.1	2.5
	30	78.2	17.7	48.1	2.6
Port Dover	3	74.9	20.7	44.5	2.5
	30	76.7	18.3	40.7	2.5

(maximum/minimum, off-land/off-water, wind speeds light/strong, winter/summer).

Field Observations

In order to verify the climatological temperature patterns and to investigate variations between observing points, temperature measurements were made from moving automobiles on August 24, 1969, just before sunrise and again in the early afternoon. From the evening of August 23 to the evening of August 24, skies were clear and regional winds at a height of 5000 feet were steady northwesterly at about 10 mph.

The advance planning for the study had included provision for two field investigations. The data collected on August 24 verified the climatological patterns so well, however, that the second field trip was not undertaken.

The automobile traverses took two to four hours and were made at times corresponding as closely as possible to the usual times of occurrence of maximum and minimum temperatures of the day. To cover a large part of the Study Area, two automobiles were used. Each was fitted with a precalibrated shielded electrical thermometer (silicon diode) connected through an amplifier to a chart recorder.

As a reliability check of the two thermometers, both traversed Highway 24 (through Simcoe). The two records agreed to within ±0.3°F. One automobile then probed the western part of the Study Area while the other one travelled east. Observations were made at intervals of about one-third of a mile with the vehicles moving at speeds of 40 mph or faster. Speeds greater than 25 mph are necessary to ensure proper ventilation of the shielded thermometers.

Automobile traverses were also made to verify the wintertime climatological patterns. These traverses were done during the mid-afternoon of February 28, 1970, and prior to sunrise March 1, 1970. The results from these traverses were quite satisfactory, and showed good agreement with the climatological analysis.

Climatic data may be analyzed in many different ways, the preferred method being dependent on the objective of the investigation in each case. In this section, some charts will be presented for the purpose of determining mesometeorological features. Other charts and tables will be included for subsequent direct application in the sections on climatic location factors.

Figures 3-4 to 3-9 show average differences in temperature at each station from concurrent values at Simcoe, the location arbitrarily chosen as reference. Where some observations are missing, the difference is bracketed and the number of observations is plotted below the station. Lines of equal temperature difference (in whole degrees F) are drawn.

Figure 3-4 shows that the air is cooler along the shore than inland, with the temperatures at Long Point averaging 5.3°F lower than at Simcoe. Cool air has moved inland up the Grand River valley and in Elgin County, but seems to have been partially blocked in Norfolk County. The highest temperatures in the Study Area are in a broad zone stretching from Delhi to Brantford. An urban heat island exists over Hamilton, and probably also over some of the other larger built-up areas.

To test the reality of the patterns, the lines were drawn independently by two different analysts. Although there were slight differences in detail, the same broad features emerged. Further verification was obtained from the automobile traverses (see discussion of Figure 3-13). As earlier research in Metropolitan Toronto has shown [6] river valleys provide preferred pathways for inland intrusion of lake air. A contributing cause for the cool temperatures over low-lying ground may be the fact that the soil is moister than average, depressing daytime temperatures slightly. The warm belt extending from Delhi to Brantford may be explained partly by the presence of the Norfolk sand plain, which is lighter and drier than the clay plain to the east; in addition, Norfolk County is generally south-facing and includes some south-facing moraines which receive above average amounts of radiation from the sun. The air in the

Figure 3-10/Average Maximum Temperature in June-Sept.

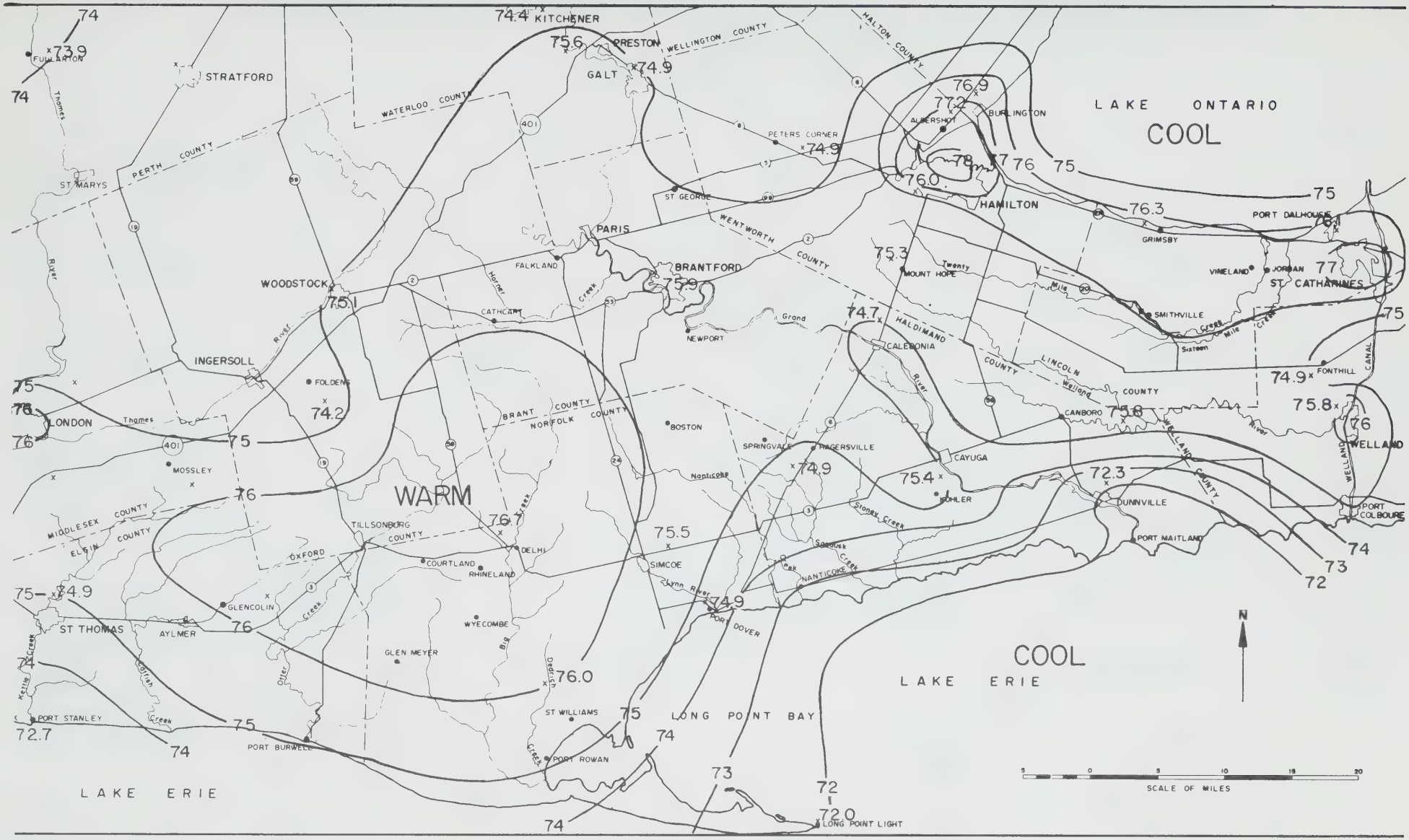


Figure 3-11/Average Minimum Temperatures in Dec.-Feb.

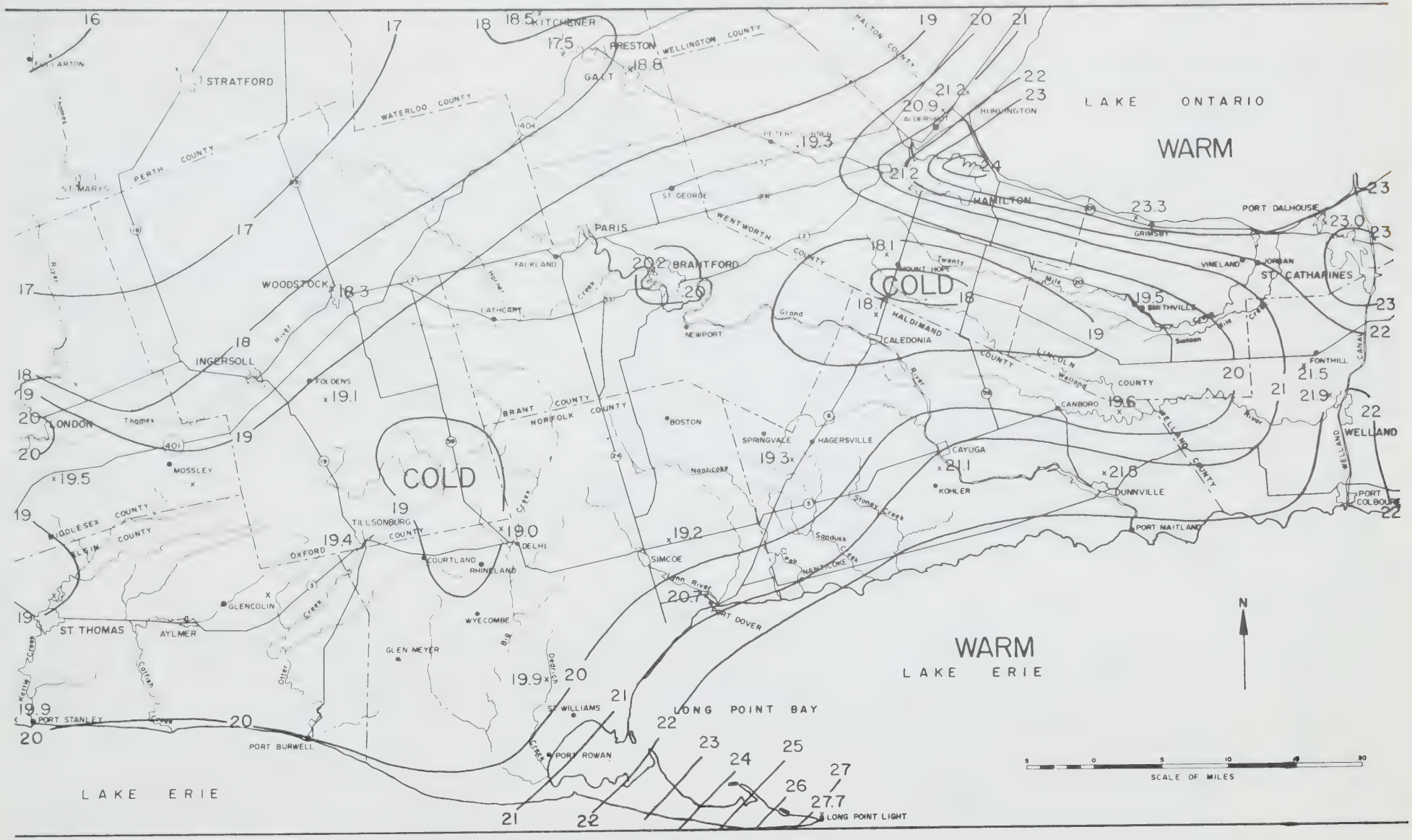
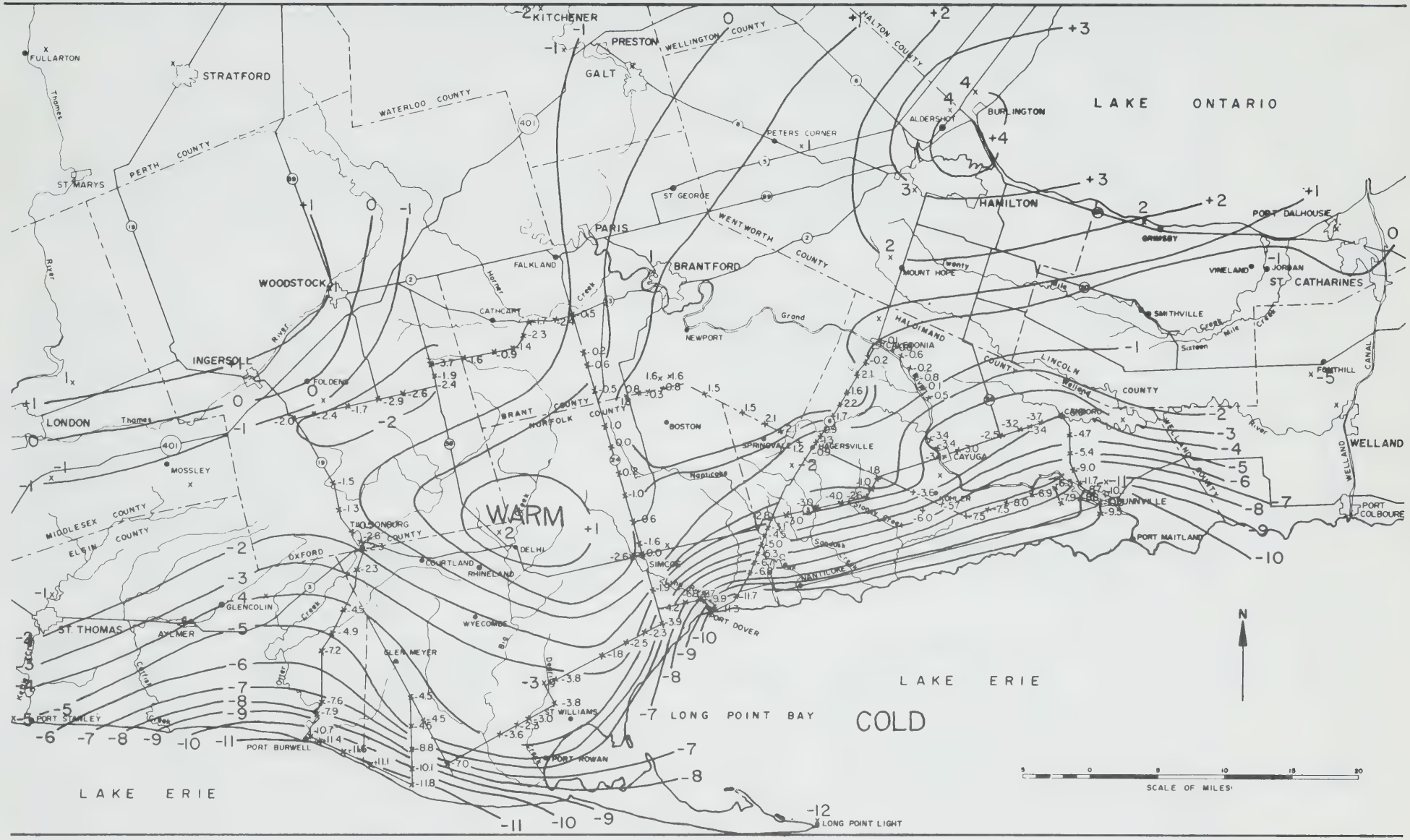


Figure 3-12/Temperature from Automobile Traverses and Maximum Temperatures from Climate Stations on Aug. 24, 1969.



Delhi-Brantford area can therefore be expected to be warmer in the day and cooler at night than the surrounding countryside. The warm pocket near Canborough is probably there because the land is south-facing and relatively well drained.

A related group, winds off the water but lighter than average (32 cases), is not illustrated because the patterns are similar to those in Figure 3-4.

Figure 3-5 is very similiar to Figure 3-4, verifying the existence of lake breezes on many sunny days, even when regional winds are off the land. Again, the preferred channels of inland penetration are up the Grand River and in Elgin County. The lighter wind-speed group (43 cases, not illustrated) yields similar patterns.

In contrast with summer, cool air intrusions are not present along the Grand River and in Elgin County (Figure 3-6). The air in the Delhi-Brantford region is again slightly warmer than average but temperatures are remarkably uniform across the Study Area. This weak temperature gradient is further verified by the wintertime automobile traverse of February 28, 1970 (Figure 3-14). The lighter wind speed class (19 cases, not illustrated) yields similar patterns, as do the off-land groups (146 and 20 cases).

At night, turbulent mixing of the air is often slight, and weather observations reflect the influence more of very local effects than of mesometeorological processes. Nevertheless, the data from the Study Area reveal well defined regional patterns. In Figure 3-7, for example, there is a slight bulge of warm air along the Grand River valley (perhaps because the soil is relatively moist) and a cold pocket north of Canborough. This pattern is more pronounced in the group with the lighter wind speeds (39 cases, not illustrated): the Canborough cold pocket is more intense (—3°F line) and another cold pocket exists in the vicinity of Delhi. This behavior is expected; radiative cooling of the air is greater when winds are less.

Figure 3-8 is similar to Figure 3-7 but the cold pockets near Canborough and Delhi are more intense. With winds blowing from land to lake, the warm air in the Grand River valley can be explained only by postulating a drainage wind which stirs the air. This behavior has been found, for example, at Chalk River where temperatures during clear nights are higher in the valley than over the plain. Similar results are found with the lighter wind-speed group (39 cases, not illustrated).

Figure 3-9 is similar to Figure 3-8. The other winter diagrams also bore such close similarity to Figures 3-8 and 3-9 that they have not been included.

Figures 3-10 and 3-11 display isotherms of average maximum temperatures for all days in December through February, respectively, for the years 1965-67. These groupings of months have been selected because they relate directly to climatic location factors. There is high confidence in the general features, which can be readily interpreted in the light of previous diagrams.

There may be some interest in the question of the representativeness of three-year averages as indicators of 30-year averages. A comparison is given in Table 3-2 for a few stations. The three-year period was cooler in summer and warmer in winter than the 30-year average. However, the regional gradients were unchanged; e.g., in summer Caledonia was cooler than Delhi.

Frequency of Temperature Extremes

A count has been made of number of days with maximum temperatures of 90°F or higher and of minima lower than zero. The regional charts (not illustrated) show features that parallel those of average summer maximum and winter minimum temperatures (Figures 3-10 and 3-11). For the months May to September 1965-67, there were no days at Long Point and Dunnville when the temperatures reached 90°. At Simcoe and Delhi, on the other hand, the frequencies of days with 90-degree temperatures were 2.4 and 3.5 percent respectively. Hot weather occurred most frequently in the northwest part of Norfolk County.

In winter (December-February), sub zero temperatures occurred most frequently in the Caledonia-Hagersville area (the northern part of Haldimand County), where the frequency of days exceeded 10 percent. At Dunnville, in contrast, the frequency was only 4 percent.

Days on which maximum temperatures do not rise above 20°F are mainly windy and/or overcast. A frequency count is therefore an index of wind-chill and human discomfort. In January, the percentage of cold days (with maximum temperatures of 20°F or lower) ranges from about 20 percent near the Lake Erie shoreline to near 30 percent in the Hagersville-Caledonia area. No special effect along the Grand River valley is present.

As a basis for comparison, Figure 3-12 included the differences in maximum temperatures on August 24, 1969, at the various climatological stations from the value at Simcoe. The differences along the north shore of Lake Erie (at Dunnville, Port Dover and Port Stanley) are larger than average values for groups of days (Figure 3-5), emphasizing the necessity for examining relatively large samples of data. Figure 3-12 also includes data from the automobile traverses. In this case, differences from the Simcoe value are given but corrected for the temperature trend over the four-hour sampling period, assuming that the Simcoe trend was representative for the region. The highest hourly temperature at the station occurred at 2:00 p.m.

The regional pattern of Figure 3-5 is confirmed. In addition, the point values given by the automobile readings are very similar to those at adjacent climatological stations.

An automobile traverse was made in the early morning of August 24, 1969, (Figure 3-13). On this occasion, scattered fog patches covered the region, resulting in considerable variability in temperature. Condensation of water vapor to fog droplets releases latent heat into the atmosphere. In addition, a heat island around local communities was observed; for example, the value at Hagersville was +1.7°F whereas, just to the northeast, differences of —4.5 and —4.7°F were measured. These local effects were smoothed away in the construction of Figure 3-13. Despite this variability, the point values given by the automobile readings are very similar to

Figure 3-13/Temperatures from Automobile Traverses and Minimum Temperatures from Climatic Stations on Aug. 24, 1969.

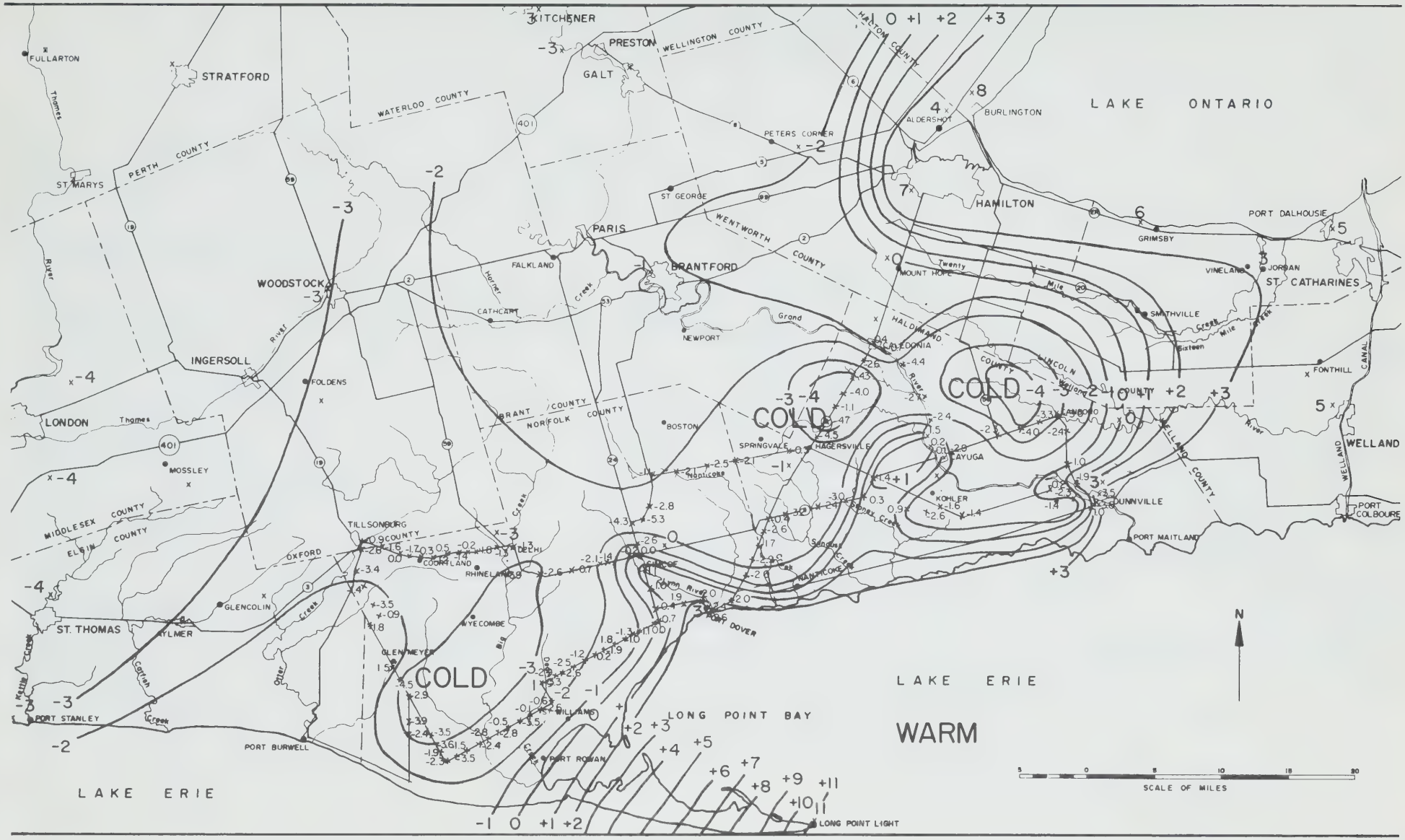


Figure 3-14/Temperatures from Automobile Traverses and Maximum Temperatures from Climatic Stations on February 28, 1970 — Wind off the Land.

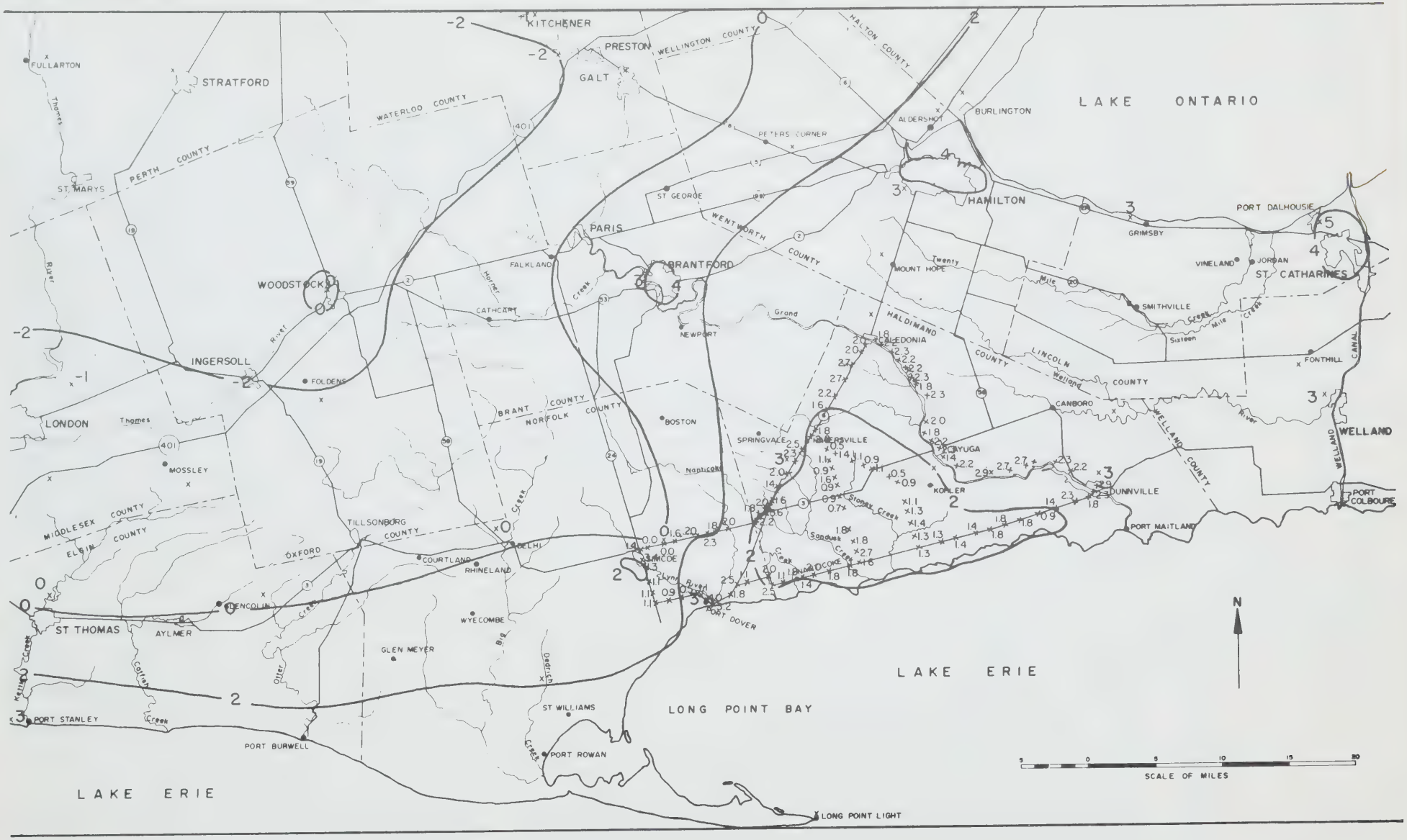


Figure 3-15/Temperatures from Automobile Traverses and Minimum Temperatures from The Climatic Stations March 1, 1970 — Winds off Land.

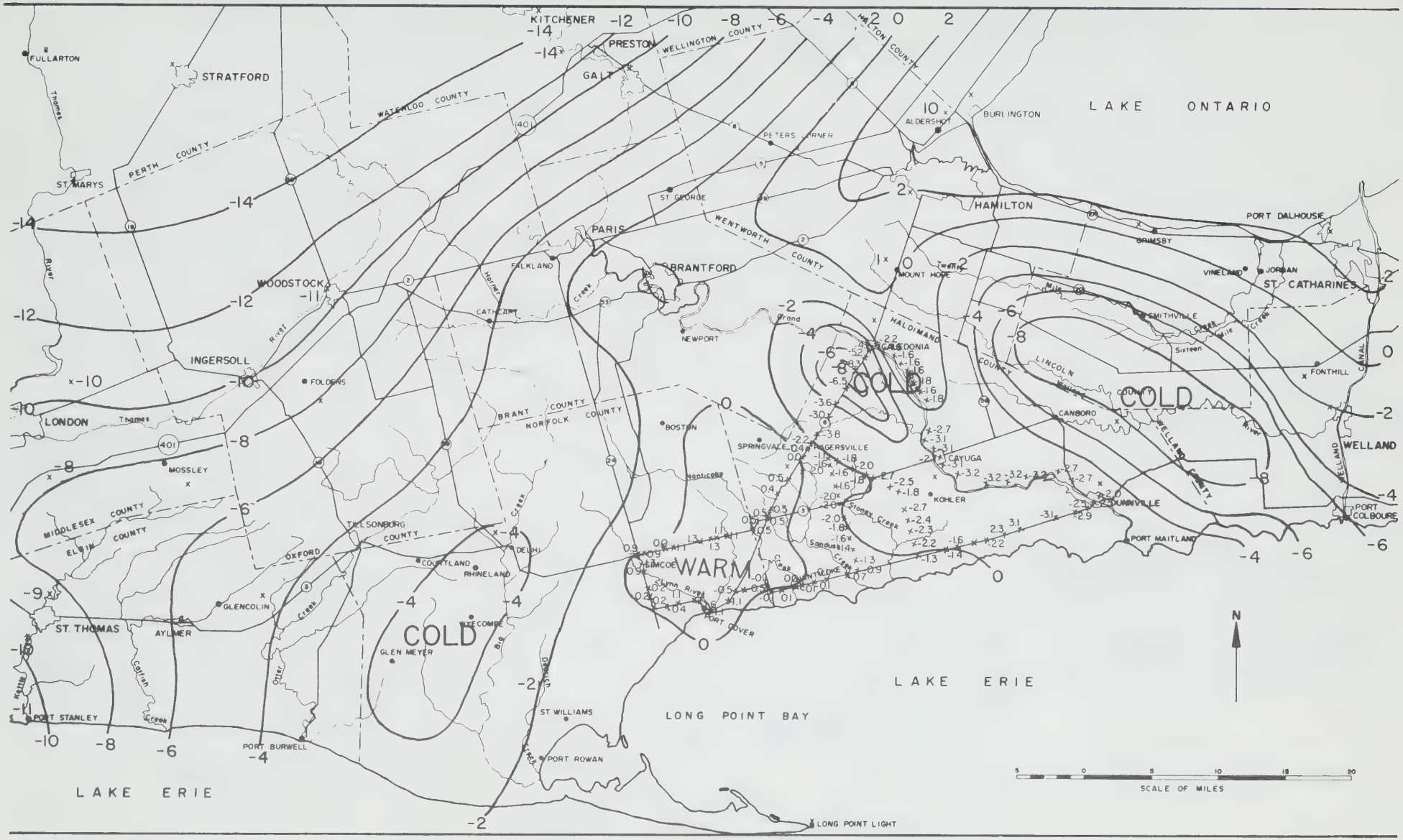


Figure 3-16/Average Annual Snowfall for the Years 1965-67 in Inches.

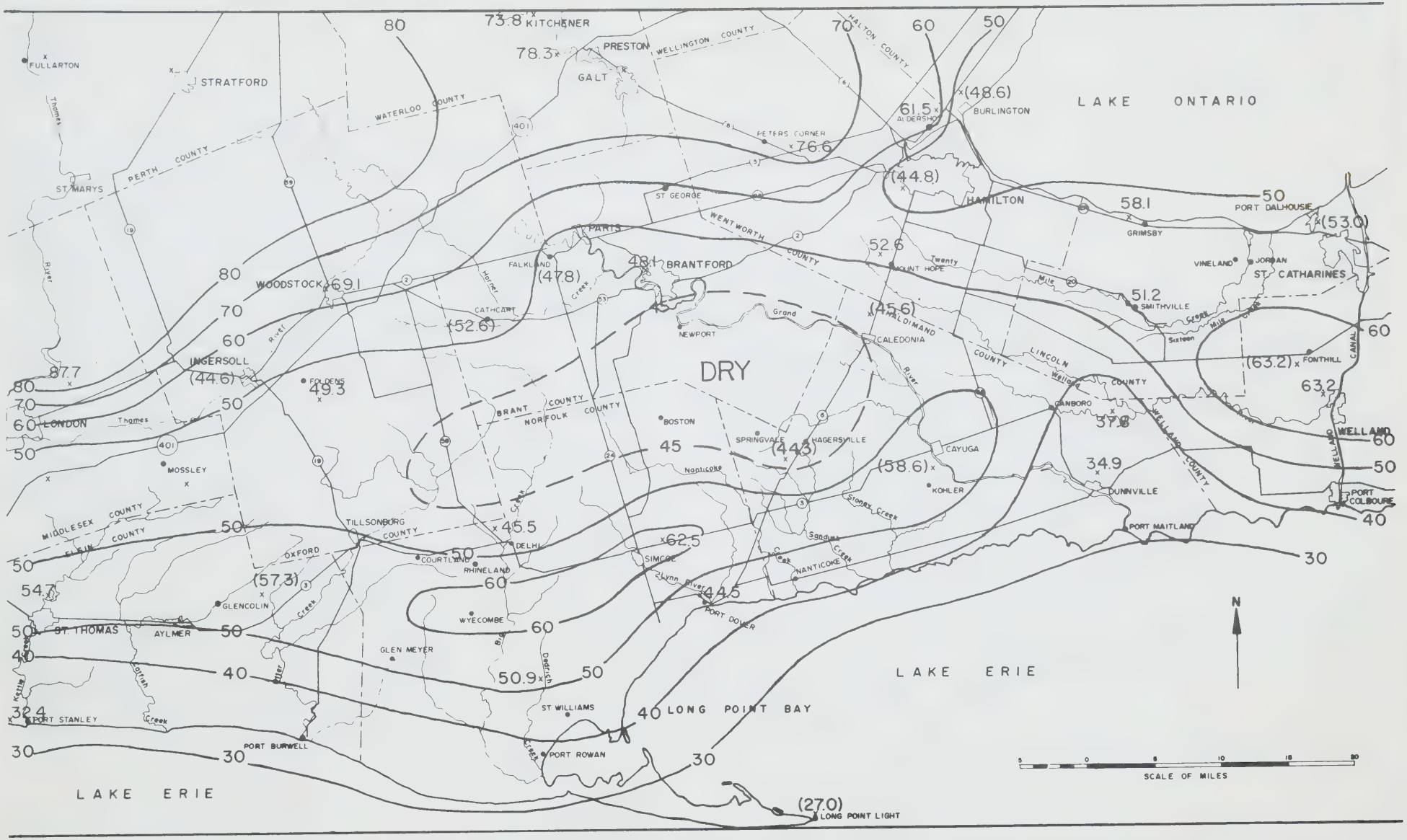


Figure 3-17/Average Monthly Rainfall for May Through September, 1965-67 in Inches.

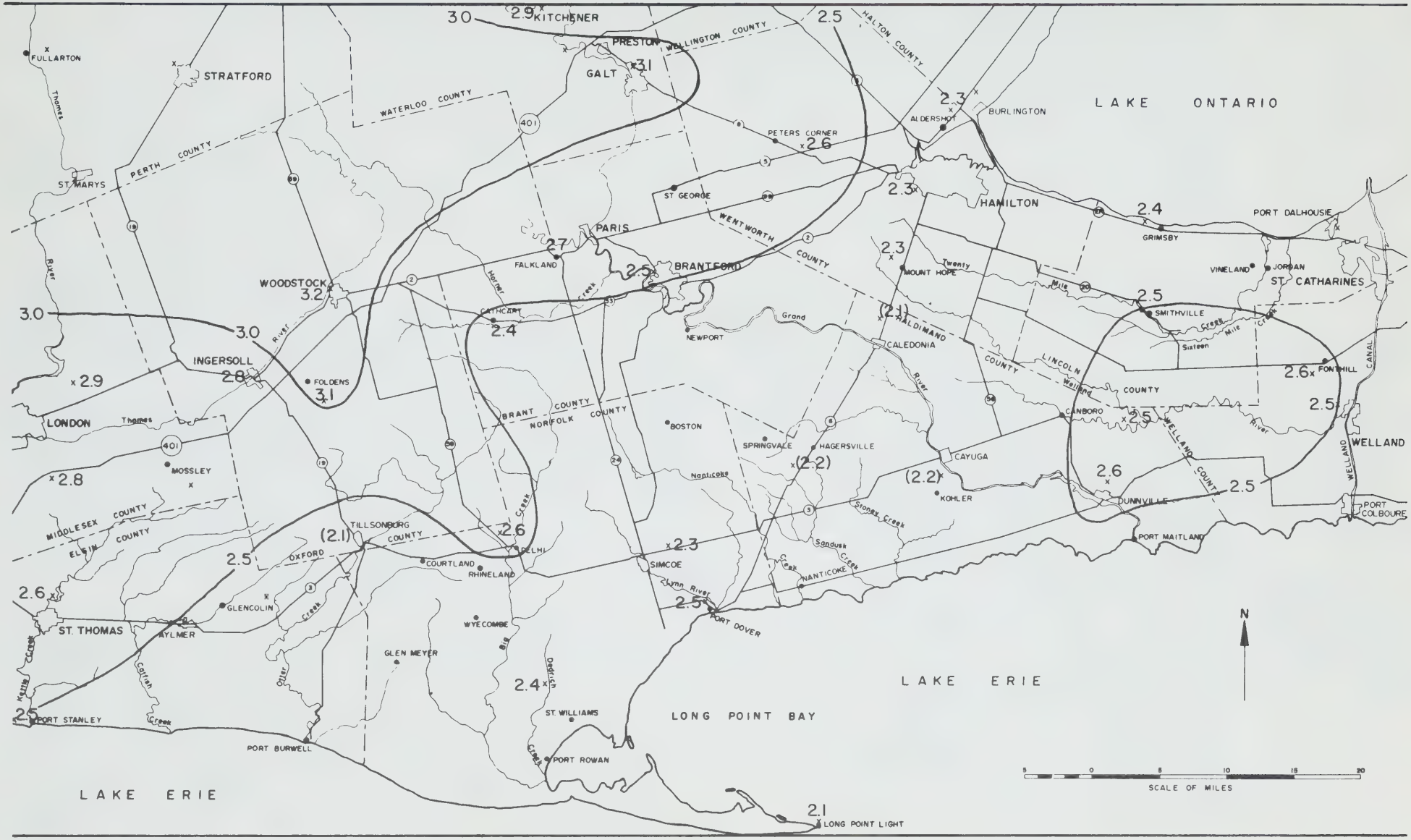
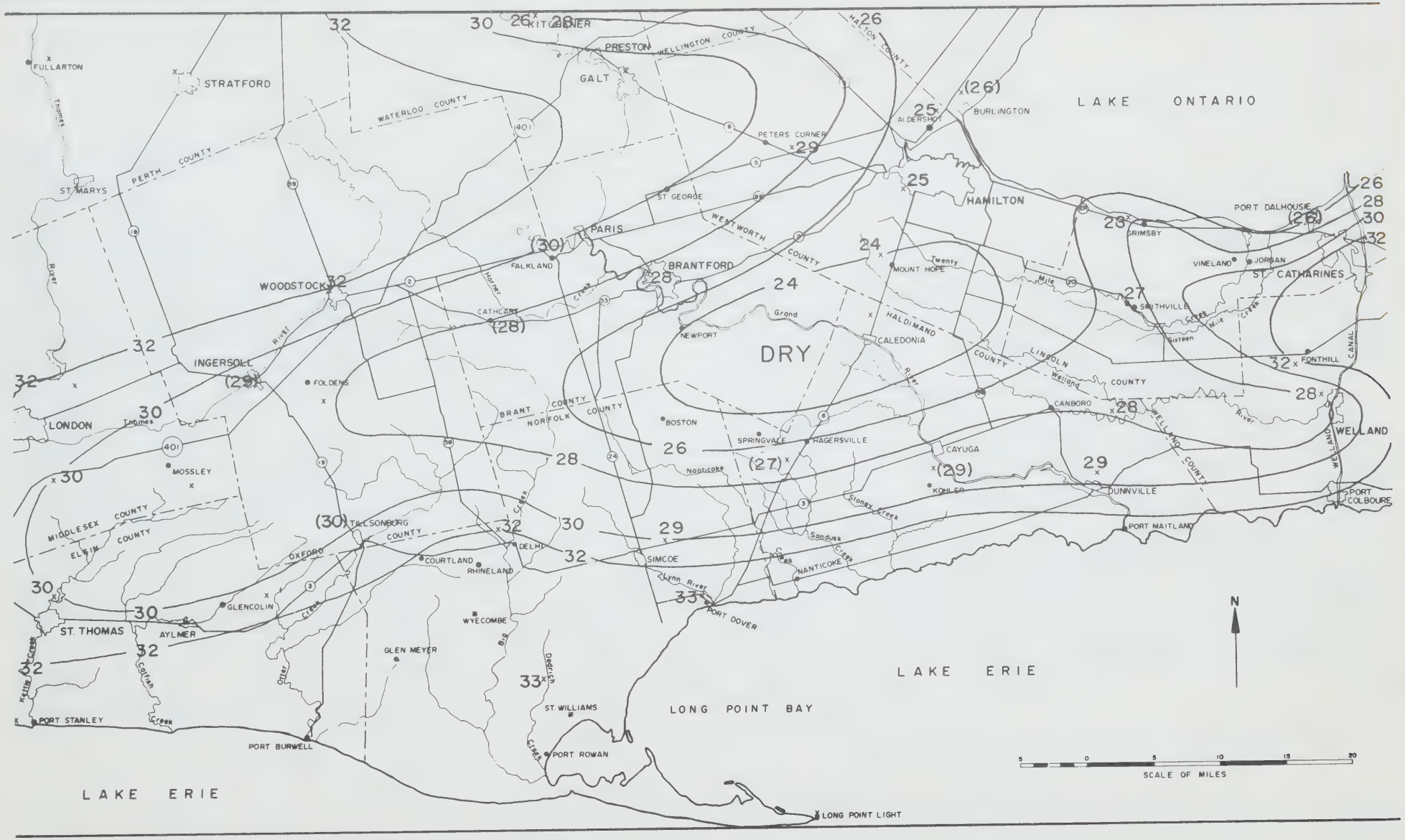


Figure 3-18/Mean Annual Rainfall Averaged over the 3-Year Period 1965-67.



those at adjacent climatological stations (with the exception of St. Williams and Delhi). Furthermore, the broad patterns are not entirely dissimilar to those in Figure 3-8.

As a basis for comparison, Figure 3-14 includes the differences in maximum temperature on February 28, 1970, at the various climatological stations from that of Simcoe.

In comparing Figure 3-14 with its counterpart Figure 3-6, showing the average temperature difference distribution in the Haldimand-Norfolk area during the winter months, there are no significant differences between the map constructed by the use of temperatures obtained from the automobile traverse and that based on the temperatures observed at the climate stations over the three-year period (Figure 3-6). In both cases, the temperature differences observed are quite small. In this figure a heat island around local communities is evident.

The automobile traverse made in the early morning of March 1, 1970 (Figure 3-15) was not completely successful, for clouds began to move into the Study Area before the automobile traverse was finished. However, because of the lengthy period of radiational cooling during the night, the data turned out to be adequate and an additional traverse did not appear necessary. As with Figures 3-12, 3-13 and 3-14, temperature differences from the Simcoe value are given, taking into account the necessary corrections as a result of the time variation of temperature during the traverse.

Figure 3-15 outlines a significant feature which did not show up using the climatological analysis of the nighttime winter data (Figure 3-9). A cold pocket is evident between Hagersville and Caledonia. The temperature difference between this area and Simcoe is approximately 10°F. The cold pocket occurs in summer also and can be considered a real frost pocket and should be taken into account for the purposes of regional planning. For example, industries should not be located in this area; winter recreation should be considered. There are no significant differences over the other areas except that the Grand River valley is susceptible to cooling as a result of cold air drainage during this time of year.

Table 3-3/ Annual and Monthly Number of Hours of Sunshine Based on 30-year Period 1931-60.

Station	Annual	J	F	M	A	M	J	J	A	S	O	N	D
Delhi	1,815	62	88	115	153	206	234	268	238	171	145	77	58
Woodstock	1,970	68	98	126	166	224	261	286	253	189	156	80	63
London Airport	1,936	63	91	128	165	231	238	283	256	184	156	79	60
Kohler*	1,754	63	74	102	145	201	231	251	227	164	150	86	60
Vineland	2,047	74	101	137	175	229	263	289	261	194	164	92	69

*Kohler records are for the period June 1947 to August 1967.

Table 3-4/Wind Speeds Associated with Very High and Very Low Temperatures at Simcoe, 1964-66

Wind Speed	Number of hours with temperatures above 85°F	Number of hours with temperatures below 0°F
1- 5 mph	11	17
6-11 mph	52	40
12-17 mph	46	43
18-23 mph	7	9
≥ 24 mph	0	0

Precipitation

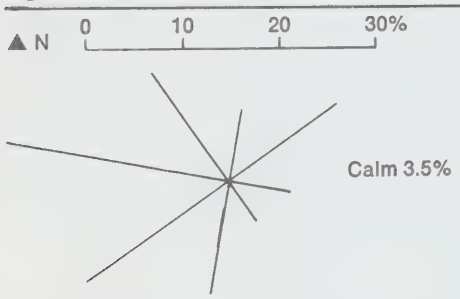
Figure 3-16 is a map of the average annual snowfall for the years 1965-67. Where values at individual stations are bracketed, some data were missing and corrections have been applied using the ratio method[7]. There is a relatively dry zone in the northern part of the Study Area, a moist band farther south, and a decrease again along the Lake Erie shoreline. The Simcoe snowfall is much higher than those at Port Dover and Delhi; this is a consistent feature of each of the three years.

Figure 3-17 shows the average monthly rainfall for the principal growing season, May through September. Again, there is a relatively dry zone in the Caledonia area but regional variations are not large — a range of only about 0.5 inches.

Figure 3-18 shows the average annual rainfall for the three-year period (1965-67). A relatively dry area is evident extending through the northern section of the two counties with the driest area centered near Caledonia. Toward the shoreline precipitation increases by about 10 inches.

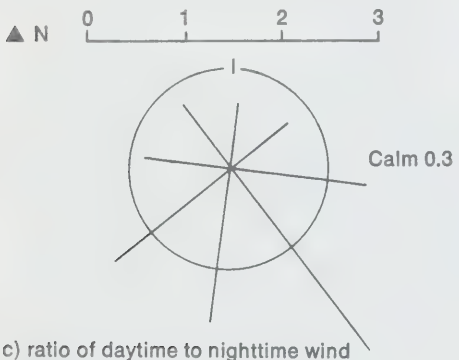
For a few selected stations, Table 3-2 indicates the representativeness of the three-year period as an estimator of 30-year averages. There is general agreement, except in the cases of snowfall at Delhi (45.5 inches compared with a 30-year annual average of 57.1 inches). This difference is probably real because there has been no change in station location or method of observation. A reasonable explanation can be deduced by examination of Figure 3-16. Delhi is on the edge of a heavy snowfall belt, and a slight northward displacement of the center would create greater falls at Delhi. Note in Table 3-2 that the Port Dover 30-year average is lower than the three-year value, as might be expected if the climatological center of heavy snow were farther north than in Figure 3-16. A possible explanation is that the snowfall maximum in the central part of Norfolk County is due to cold-air flows off Lake Erie. Snow squalls occur along the shoreline also in these situations but there is a counterbalancing factor — the occurrence of rain near the lake on occasion instead of snow when a low-pressure area moves across or to the south of Ontario, reducing the winter total snowfall at Port Dover and Long

Figure 3-19/Simcoe Wind Roses

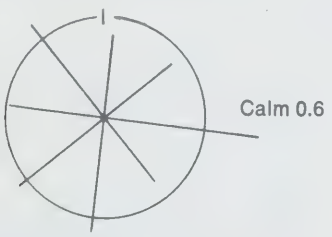


a) all hours 1964-66

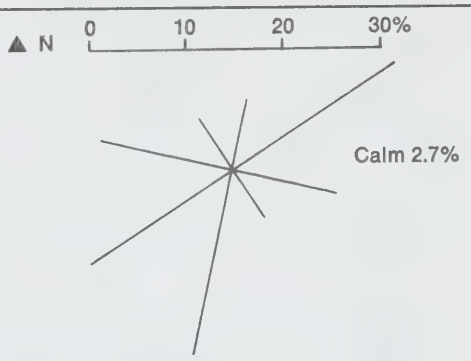
b) hours when speed was more than 23 mph



c) ratio of daytime to nighttime wind frequencies in summer

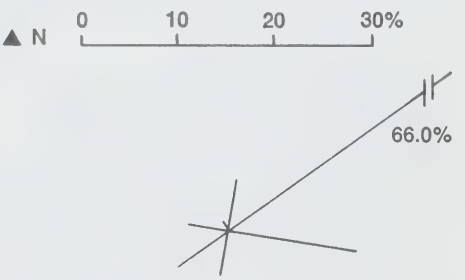


d) ratio of daytime to nighttime wind frequencies in winter



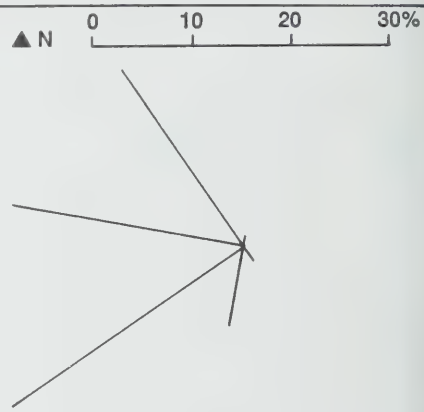
e) hours when rain was falling

f) hours when snow was falling

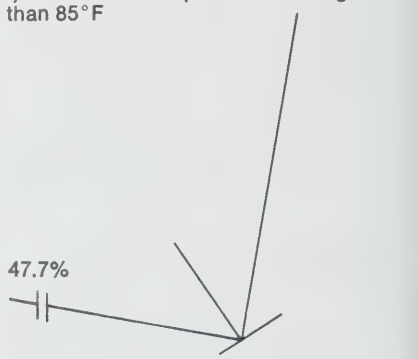


g) hours when freezing rain was falling

h) hours when visibility was less than 5/8 mile



i) hours when temperature was higher than 85°F



j) hours when temperature was lower than zero

Point. Figure 3-18 appears to confirm this. The mean annual rainfall (1965-67 normal) is heavier near the lakeshore than further inland — accounting for those occasions during the winter when rain rather than snow occurs near the shore.

Hours of Sunshine

The monthly and annual numbers of hours of sunshine are given in Table 3-3 for a few stations in and near the Study Area. The Kohler data are not for the standard 30-year period and therefore are not directly comparable.

In both winter and summer, Woodstock and London Airport have similar sunshine climates. Delhi (and probably Kohler also), on the other hand, have slightly more cloudiness. Nevertheless, the regional differences do not appear to be sufficiently great to be of importance as a climatic location factor.

Simcoe Wind Roses

The Simcoe hourly winds for the years 1964-66 have been analyzed in a number of ways.[8] The use of winds from a single station requires comment, seemingly contradicting the philosophy underlying this report. The fact that only one hourly observing station exists in the region is not in itself sufficient justification. With careful interpretation, however, Simcoe wind roses provide some useful clues about regional flow patterns (Figure 3-19). In the first place, because the Study Area is relatively flat, Simcoe winds are undoubtedly representative when speeds are strong, *i.e.,* more than about 20 mph. On such occasions, the mesometeorological influences are small. Secondly, a separation of the data according to season and time of day yields information about the lake breeze in the southern part of the Study Area; care must be taken, of course, not to extrapolate to the Grand River valley where the lake breeze appears to be stronger.

Although winds at Simcoe are observed to 16 points of the compass, roses have been constructed to only 8 points by combining cases of N and NNE, NE and ENE, etc.; these will be called northerly, northeasterly, etc. The radial lines in Figure 3-19 have been offset an appropriate amount to compensate for the above combinations.

Figure 3-19 (a) is a wind rose for all hours at Simcoe, while Figure 3-19 (b) includes only hours when the speed was more than 23 mph. The prevailing wind is westerly, as expected. With strong winds, however, the most frequent direction is southwesterly and there are fewer cases in the eastern semicircle.

To examine the effect of the lake, a special representation has been devised [Figures 3-19 (c) and 3-19 (d)]. The length of each radial line is proportional to the ratio of daytime to nighttime wind frequencies for that particular direction. The circles represent a ratio of unity. Daytime arbitrarily includes the hours 8:00 a.m. to 8:00 p.m. EST in summer and 8:00 a.m. to 5:00 p.m. EST in winter. Nighttime includes the hours 9:00 p.m. to 7:00 a.m. and 6:00 p.m. to 7:00 a.m. in the two seasons, respectively. Figure 3-19 (c) (May-August, inclusive) shows a surplus of off-water winds in the daytime and off-land winds at night, verifying qualitatively the maximum and minimum temperature charts discussed previously. In winter (December-February, inclusive), surprisingly, the same day-night differences seem to exist, although they are not so marked. At that time of year, there must be a few days when the air temperature over the land exceeds that over the water.

Figures 3-19 (e), (f), (g), (h) show wind roses for annual frequencies of hours of rain, snow, freezing rain and poor visibility (less than five-eighths of a mile), respectively. Each of these diagrams has a characteristic pattern.

Finally, Figures 3-19 (i) and (j) display wind roses for hours when the temperature was higher than 85°F and lower than zero, respectively. Both very warm and very cold weather are associated mainly with winds from the western semicircle. Because heat stress and wind-chill depend partly on wind speed, the results given in Table 3-4 are of some interest. The data show that there was usually at least a slight breeze during hot weather; in winter, significant numbers of very low temperatures were associated with speeds of over 10 mph, contributing to wind-chill and human discomfort.

Air Pollution

As indicated at the beginning of this chapter, climate affects different human activities in different ways. There is no unique set of climatological statistics that can be applied universally, and the important parameters creating stress must be identified in each case.

Air Pollution Meteorology

Air quality depends on emission strengths and on meteorological dispersion rates. High pollution potential is defined as a meteorological condition which, given the existence of multiple sources, is conducive to the occurrence of high concentrations of pollution. The definition is in terms of meteorological conditions only; high pollution potential may occur in unpopulated areas where air quality is excellent, in the Canadian arctic, for example. In regional planning for industrial expansion, pollution potential is, of course, very important.

Meteorological conditions causing high air pollution potential include light winds (poor horizontal ventilation) and temperature inversions (poor vertical ventilation). Inversions of mesometeorological importance in the Study Area are of two main types:

1) *Radiation inversions,* which occur at night when skies are clear and winds are not strong. The air near the ground cools more rapidly than does the air at heights of a few hundred feet. Once the inversion begins to form, the surface wind diminishes because of increased air stability, thus adding to the pollution potential by reducing horizontal ventilation. The intensity of a radiation inversion depends on the nature of the underlying radiating surface and on topography; slopes and river valleys promote air drainage whereas enclosed hollows favor inversions (as well as frost). Radiation inversions usually disappear when the ground is heated a few hours after sunrise, but reform near sunset. They are absent when skies are cloudy or winds are strong.

As part of the Tobacco-Fleck Project, a 100-foot meteorological tower was in operation in Port Burwell in the summers of 1959-61, yielding hourly values of vertical temperature differences between 20 and 100 feet.

With the exception of one night of observation, there was an inversion of at least four hours' duration, while the average duration was 11.3 hours.[9] The Port Burwell measurements are in qualitative agreement with data obtained from towers in other parts of Ontario, for example those near Sarnia, and in Ottawa.

2) *Lake inversions,* which occur when the lake is cooler than the adjacent land. Sometimes the air at a height of 500 feet over Lake Erie is 30° warmer than is the water. This situation occurs most frequently in spring and summer. When regional winds are southerly at that time of year, the lake inversion moves inland at night to enhance the radiation inversion. During the daytime, with regional warm southerly winds or with lake breezes, the inversion is eroded from below as illustrated in Figure 3-2. Pollution from a tall shoreline chimney moves inland with very little dilution until it intersects the lower unstable convection layer. At that point, perhaps several miles inland, (the actual distance will vary from place to place; specific night studies are needed to better describe this phenomena in the Study Area) the pollution fumigates to ground level. In the case of a lake breeze, and when the chimney gases are very hot, the plume may rise sufficiently to reach the layer of return flow from land to lake as illustrated in Figure 3-2. This behavior has been observed at the Lakeview Generating Station in Port Credit, for example. In the absence of direct measurements from the Study Area, regional maps of maximum temperatures during clear skies can be used to infer regional variations in lake breeze intensity.

Air pollution is of two general types. Each has its characteristic set of meteorological conditions creating high pollution potential.

1) *The products of incomplete combustion,* the classical type consisting mainly of smoke, sulphur dioxide and hydrogen sulphide from domestic, industrial and space-heating sources. Seasonally, poor air quality of this type occurs most frequently in late autumn when the days are short, the sun is weak, and there are spells of light winds.

2) *Photochemical smog,* in which sunlight causes a reaction between nitrogen dioxide and hydrocarbons (mainly in automobile exhausts) to form oxidants. Oxidants cause cracking of rubber, corrosion of nylon, watering of eyes and irritation of skin and lungs. This is the principal type of pollution in Los Angeles, and there is evidence of its existence in Ontario in summer. A contributing factor in the latter region is the Lake Erie inversion, which acts as a reservoir for the ingredients of the reaction. Most of the nitrogen dioxide and hydrocarbons come from the densely populated south side of the lake. On sunny days when winds are southerly, oxidant levels rise along the north shore of Lake Erie. Detailed studies have shown that tobacco fleck in the Port Burwell area is caused by oxidants carried inland by the lake breeze.[10] In winter, on the other hand, the sun is not sufficiently strong to initiate photochemical reactions in Ontario, and oxidant levels remain low.

Air Pollution Climatology

In the last ten years, there has been increasing interest in simulation models of regional pollution. The first study was by F. N. Frenkiel[11] and, more recently, models have been proposed for the state of Connecticut by N. E. Browne[12] and for the Washington to Boston "megalopolis" by D. H. Slade.[13] A study of Metropolitan Toronto has begun. As an indication of the increasing interest in pollution models the first international symposium on the subject was held at the University of North Carolina in October 1969.

To summarize briefly for the non-specialist, a particular pollutant (usually sulphur dioxide or carbon monoxide) is selected for study. An inventory of emission sources and strengths is undertaken by a team of engineers. Using meteorological information, the atmospheric diffusion equations are solved on a computer for each source, yielding the dispersion pattern around that source. This is done for each chimney or residential block. The values are added together to produce an estimate of the regional pattern of ground level concentrations. The model is said to be verified if these values agree reasonably well with measured concentrations at a network of sampling stations.

Once the model has been verified, the effect of industrial expansion or changing land use is simulated by merely varying the source strengths and reprogramming the computer. The assumption is made that atmospheric conditions remain unchanged.

Simulation models are expensive, sometimes costing hundreds of thousands of dollars. In the present state of development, mesometeorological processes such as lake breezes are frequently ignored, and the emission inventories often give only annual or seasonal rates whereas the daily cycle is important. Without denying the value of computer modelling, and recognizing that many refinements will be possible in the next ten years, there is a need for a meaningful inexpensive alternative. The following approach, although necessarily somewhat qualitative, appears to be of value in regional planning. It is also recommended as a preliminary step that should be undertaken to ensure that the simulation model has some physical basis.

In summary, the mesometeorological processes must first be identified. Armed with a knowledge of their influences on pollution potential, the air pollution meteorologist can employ physical reasoning to recommend various combinations of land use that will minimize pollution problems. He must, of course, recognize that climate is only one of the many location factors, and that air quality cannot always be optimized in the overall regional plan. Furthermore, because there are two types of pollution potential — the products of incomplete combustion and photochemical smog — it may not be possible to minimize both in a single regional plan.

One approach that has been widely used in the nuclear energy industry, for example, is a diffusion classification based on standard hourly weather observations of sunshine, cloudiness and wind speed from first-order stations.[14] This method has been used for a large number of stations in the British Isles.[15] In the Haldimand-Norfolk

area, however, wind data are available from Simcoe only, while the network of sunshine stations is sparse. Indirect inferences are therefore necessary.

Air Pollution Location Factors
Heavy industry should not be located in a large urban area until the kind of provincial or local legislation is devised which will, *in fact,* control the environmental pollution industry usually causes. It is senseless to repeat the mistakes of Buffalo, Cleveland, Detroit and Hamilton. Although chimneys can be made high enough, and precipitators installed to remove sufficient particulates to meet existing air quality standards, the industrial zone will always be an eyesore and there is no reason to doubt that air quality standards will become increasingly stringent over the next 50 years.

In general, heavy industry requires a plentiful supply of water and therefore will be located on the Lake Erie shore of the Study Area. In spring and summer lake inversions will create problems. Unfortunately for agricultural interests, this is the time of year when vegetation is most susceptible to air pollution damage.

Order-of-magnitude calculations (Appendix A) indicate that zones of heavy industry along the lakeshore should be separated from residential areas by buffer regions (Figure 3-20). Within these sectors, land use would gradually be converted from agricultural to light industry over the next 50 years. As a further barrier to pollution transport into residential areas, however, a greenbelt is recommended, one-half mile in width. The trees not only act as filters but the additional space permits the pollution to become diluted over a larger volume. (Hyde Park and Kensington Gardens in London, for example, provide a reservoir of clean air.[16]) The radius of the buffer zone shown in Figure 3-20 depends, of course, upon the magnitude of the projected emissions by heavy industry as well as upon whether the air quality criteria become more stringent in the next 50 years. These are technical questions that can be resolved by the Air Management Branch of the Department of the Environment. The important principle is that a buffer zone be established, based on the total projected emissions by heavy industry. When this emission rate is reached, no further expansion should be permitted.

Having considered these general principles, a discussion of the mesometeorology of the Study Area is relevant. In the first place, the inland penetration of the lake breeze is about the same over the entire region except in the western and eastern extremities (see Figure 3-4, for example). On a relative scale, the Port Maitland-Dunnville area is a poor choice for the location of heavy industry, and further development should be discouraged. In addition, parklands up the Grand River valley as far as Caledonia should be protected. The Nanticoke area, on the other hand, is a preferred choice for shoreline industrial land use.

There are no direct measurements of inversion frequencies in the Study Area. However, regional maps of minimum temperatures during clear skies can be used to infer regional variations in the radiation inversion climate. In areas of relatively low temperature, inversions are more prevalent and more intense.

Figures 3-8 and 3-9 reveal overnight cold pockets in the vicinity of Delhi and northeast of Canborough. These cold pockets are further substantiated by the automobile traverses of August 24, 1969, and March 1, 1970 (Figures 3-13 and 3-15 respectively). These figures also reveal a major cold pocket between Hagersville and Caledonia. These areas have relatively high pollution potential, particularly for ground level sources such as automobile exhausts. Preferred sites for residential development are therefore in the vicinity of Hagersville or along the Lake Erie shore (but at least 8 to 10 miles from heavy industry).

The climate will change in areas that become built up (see Table 3-1). Nevertheless, if a city is located in an inversion-prone area, the frequency of stagnation periods will be higher than average, despite the existence of an urban heat island. The recommendations in the previous paragraph are not therefore affected.

Part of the summer oxidant problem cannot be avoided because the sources are on the south shore of Lake Erie. However, the tobacco fleck studies and the reports of cracking of automobile tires in a Hagersville storage area indicate that an effort must be made not to aggravate the problem. Pollution-free rapid transit systems for transporting large numbers of workers should be included in long-term plans.

Finally, the upper part of the Grand River from Caledonia to Brantford seems capable of supporting a modest amount of industrial growth without unduly taxing the dilution capability of the atmosphere. The nighttime drainage flow is a favorable factor, although there may be cogent reasons for other kinds of land uses.

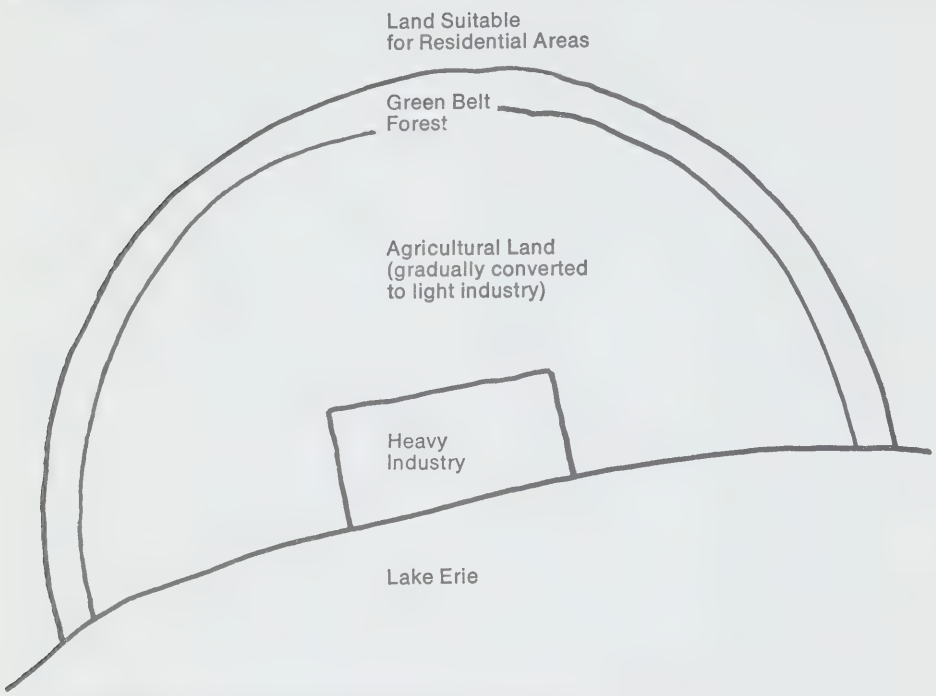
Agriculture and Forestry

Meteorological Stresses on Vegetation
Many factors limit agricultural yield and cause damage to crops and forests. Of the various kinds of stress, the following are of meteorological significance:
1) air pollution damage;
2) soil moisture stress, including an excess of water;
3) deficiencies in sunlight or warm temperatures;
4) unseasonable frosts;
5) gales;
6) weather-sensitive pests, rusts and molds.

Vegetation Climatic Location Factors
Using the results of the data analysis, the easiest stress to identify regionally in the Study Area is frost. Figure 3-8 and Table 3-5, which compares frost statistics at several locations within and around the Study Area, indicate that the most frost-prone sections are in the vicinity of Delhi, in an area between Hagersville and Caledonia, and along the Haldimand-Lincoln boundary. The chances of unseasonable frost are least near the Lake Erie shoreline and along the Grand River valley.

Atmospheric pollution has been discussed already. Summer oxidant problems are widespread, and little can be done in terms of regional planning except to discourage large concentrations of automobiles. Because photochemical pollution is a meso-

Figure 3-20/Schematic Representation of Recommended Relative Locations for Heavy Industrial and Residential Zones.



meteorological phenomenon, restricted agricultural land use near busy highways is not a solution. In the case of conventional pollution from chimneys, the previous recommendation of an ultimate 8- to 10-mile separation zone applies, although this goal may be achieved only gradually over a period of 50 years.

Soil moisture stress depends on the storage capacity of the soil, on precipitation (particularly during critical periods of growth) and on evapotranspiration losses (evaporation from the soil plus transpiration from leaves). Only indirect inferences can be made about these variables from the data. Recently, researchers have studied the evapotranspiration from perennial ryegrass at the Simcoe Horticultural Experimental Station.[17] Their results are informative but do not provide any clues about regional patterns. When soil moisture is not limiting, evapotranspiration rates can be correlated with simple meteorological measurements such as sunshine, wind and atmospheric humidity: water losses are greatest when the sun is shining, winds are strong and humidity is low. Examination of these factors in the Study Area suggests that there is little regional variation in evapotranspiration. The air is slightly more humid within a few miles of Lake Erie but the wind is undoubtedly a little stronger there than inland.

Monthly rainfall during the growing season (Figure 3-18) also indicates little regional variation. The remaining factor — soil moisture storage capacity — is discussed in Chapter 7.

A third factor, deficiencies in sunlight and/or summer heat units, is not expected to be a yield-limiting stress in the Haldimand-Norfolk area. The native species are adapted to their environment, and the farmer has learned from experience the kinds of crops he should plant.

The other types of meteorological stresses (frequencies of gales, and the existence of weather sensitive pests, rusts and molds) cannot be evaluated regionally from the available data.

Outdoor Recreation

Outdoor Recreation Climatology

In summer, the Lake Erie shoreline is widely used for recreation. In addition, there are sports such as golf and tennis, and outdoor picnics and camping in wooded areas which begin in spring and continue well into the autumn. The climatic factors of importance include above average sunshine and below average frequencies of periods of rain.

In winter, outdoor recreation includes skating and various activities connected with snow. A preferred climate is one in which temperatures are lower than average and snowfall is greater than average.

Outdoor Recreation Location Factors

For various non-meteorological reasons, a significant fraction of the Lake Erie shoreline should be preserved for summer recreation. Climatological considerations support this view; preferred locations for public parks and for golf and tennis courts are within a mile or so of the lake. The Lake Erie summer inversion has a damping effect on convection, suppressing afternoon showers along a narrow coastal strip.

Winter nighttime temperatures (Figure 3-12, for example) are relatively low in the vicinity of Delhi between Hagersville and Caledonia, and along the Haldimand-Niagara boundary while daytime values are not above average (Figure 3-7). These are, therefore, preferred areas for outdoor skating rinks.

Nowhere in the region is snowfall ideal for tobogganing and skiing. There is a snowbelt in the Simcoe-Kohler region, but the snow is probably more of an inconvenience than an asset for recreation. The chances of thaws are greater there than farther north every time warmer air enters the region. The extreme northern part of the Study Area, although drier, is likely to have a more persistent cover of snow. North-facing slopes of moraines in Norfolk and Brant Counties should be selected, and conditions can be improved locally by surrounding the recreation areas with thick shelter belts to promote frost pockets and to reduce evaporative losses of the snow-pack by wind.

Table 3-5/Comparison of Frost Conditions at Several Locations Within and Around the Study Area

	No. of Years Considered	Average Frost-Free Period (Days)	Last Frost (Spring)			First Frost (Fall)		
			Average	Earliest	Latest	Average	Earliest	Latest
Caledonia	19	142	May 14	Apr. 20	June 8	Oct. 3	Sept. 12	Oct. 25
Dunnville	3	157	May 6	May 1	May 10	Oct. 10	Oct. 6	Oct. 16
Vineland	25	175	Apr. 28	Apr. 11	May 21	Oct. 20	Sept. 28	Nov. 6
Simcoe	43	135	May 17	Apr. 20	June 8	Sept. 29	Sept. 4	Oct. 24
Port Dover	51	155	May 8	Apr. 2	May 29	Oct. 10	Sept. 12	Nov. 2
Brantford	63	142	May 13	Apr. 9	June 23	Oct. 2	Sept. 10	Oct. 6
London	58	138	May 16	Apr. 17	June 16	Oct. 1	Sept. 9	Oct. 28
Delhi	16	133	May 19	Apr. 13	June 8	Sept. 29	Sept. 5	Oct. 13

Human Comfort

Climatology

The principal atmospheric stress on humans in the Study Area is heat. A large number of comfort indices have been proposed.[18] The thermal balance of the body is very complex, however, depending on air temperature, wind, sunlight, humidity, and type of clothing, as well as on many physiological factors such as health, climatic adaptation, and metabolic rate. It seems that a heat stress index should be as simple as possible. Many scales are based on temperature and humidity but there is merit in the suggestion that "hours of sunshine" is a useful summer comfort index.[19] Baker finds that this one factor correlates well with other more complicated formulae.

In winter, wind-chill is a well-established phenomenon, creating human discomfort as well as adding to space-heating fuel bills. A simple index of wind-chill is the frequency of cold days: this is preferable to the frequency of cold nights because on many of these latter occasions, winds are light and body heat losses are not great.

Location Factors

During periods of hot weather, the cooling effect of the lake breeze quickly diminishes inland, except along the Grand River valley. The cooler air at the shoreline is more humid, however, so that human comfort is not appreciably greater, particularly when vigorous exercise is undertaken. Using summer sunshine (Table 3-3) and temperature as indices, it appears that regional differences are insufficient to be important as a location factor.

A good index of wind-chill and human discomfort would be days on which maximum temperatures do not rise above 20°F. These days are mainly windy and/or overcast. A frequency count of these days over the Study Area during January ranges from about 20 percent near the Lake Erie shoreline to near 30 percent in the Hagersville-Caledonia area. Taking these points into consideration, it would appear that the preferred location for urban areas is near the shore.

An additional factor that plays an important part in human comfort is the dispersion of industrial pollution in the area of human activity. The mean wind in the Nanticoke area is west to northwest. The pollution emitted in this area would therefore be dispersed toward the east. A major pollution problem, however, often exists under inversion and light wind conditions. In southern Ontario this condition is often associated with easterly or northeasterly winds. It would thus appear that an urban area near the lakeshore, both to the west and east of Nanticoke would have a pollution problem on occasions.

Based then on only the various meteorological factors, a large urban development to the north and northwest of Nanticoke would probably be preferred.

The heat-stress and wind-chill wind roses [Figures 3-19 (i), (j)] provide clues about optimum physical arrangements for residential areas. The wind roses indicate that the land should be open to the southwest and west (to promote summer ventilation), but closed by shelter belts to the north (to reduce wind-chill).

Transportation

Climatology

Transportation (automobile, rail and air) is weather sensitive to snow, freezing rain and fog. When visibility is poor, traffic is interrupted and accident rates increase.

Location Factors

On a regional basis, the snowbelt in the central part of the two counties (see Figure 3-16) should be avoided for major traffic arteries and airports. The Grand River valley and a strip within a mile of the lake are excluded also because fog is most prevalent in low-lying moist areas. Thus, if a major east-west traffic artery is considered, it should be located on a Hagersville-Delhi line.

Sandy soil is preferred for airport location according to the federal Department of Transport. The Norfolk sand plain is therefore recommended for a major airport location, but at a site not too close to the lake and also not within the snowbelt of Figure 3-16.

Existing patterns of snowfall and freezing rain will change with the growth of urbanization. The resulting heat island will produce more rain and less snow and freezing rain than at present. Fog, too, is slightly less severe in cities because the ground is drier

and temperatures are higher than in surrounding areas. Urbanization will therefore create a favorable climatic amelioration for the transportation industry.

The special wind roses [Figures 3-19 (f), (g) and (h)] may be of a value in local design studies. Snow [Figure 3-19 (f)] rarely occurs at Simcoe when winds are from the southeast quadrant, information that can be used to advantage in the orientation of buildings and groups of buildings. Freezing rain occurs mainly with northeasterly winds while fog frequencies are not particularly dependent on the direction of air flow. Examination of particular wind roses for only strong wind speeds at Simcoe yielded the same patterns, suggesting that these results are general throughout the region, in a qualitative sense at least.

The climate of the Haldimand-Norfolk Study Area has been examined in this report and has been related to various location factors. The principal conclusions are as follows:

1) The Nanticoke area is preferred for heavy industry; further development in the Port Maitland-Dunnville region is to be discouraged.[20]
2) The zone of heavy industry should be surrounded by a residential exclusion area, a buffer zone.
3) Urban centers should be located at or near the Lake Erie shore, but in locations that will not be influenced by pollution from industrial sources.
4) Much of the Lake Erie shoreline should be preserved for summer recreation.
5) Winter recreation areas should be located on the north-facing slopes of moraines in Norfolk and Brant Counties.
6) The upper Grand River valley should be shared between recreational and light industrial interests.
7) The frost-prone areas are in the Delhi vicinity and along the Haldimand-Niagara boundary but this is probably not an important location factor because the farmer has undoubtedly adapted his cropping schedules to this fact.

The broad climatic patterns of the Study Area have been revealed. Nevertheless, the following recommendations for further meteorological investigations are made.

1) Vertical soundings of temperature should be made near the lakeshore to determine depth and strength of lake-caused inversions. This information can be used directly by engineers or meteorologists for chimney height design.
2) Modifications in local weather caused by urban and industrial growth should be followed over the next several decades. In most cities of the world, no meteorological observations are available for the pre-city era. The climatologist therefore has difficulty in separating the urban from the natural orographic weather influences. The Haldimand-Norfolk area provides an exciting opportunity to examine these changes. Not until the land use patterns have been established, however, can precise recommendations be made concerning types and location of additional weather observing stations.
3) Although the mesoclimate has been dissected and location factors have been proposed, extrapolation to the smaller domain of micro-meteorology is sometimes dangerous: the climate of a forest clearing, for example, is dominated by micrometeorological processes. Continuing cooperation between regional planners and meteorologists is essential, particularly when decisions are to be made about local details.
4) As an aid in preserving air quality, the development of a regional air pollution simulation model is recommended. The model should be completed prior to extensive industrial development. Such a model would allow control agencies and planners to preview how additional industrial and urban development will affect the air quality of the area.

Footnotes/References

Footnotes

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Introduction

A place rich in land and water resources — this is what southern Ontario was less than 200 years ago. In the years of permanent settlement of the Lake Erie region of southern Ontario, drastic alterations in the fabric of the natural environment have occurred. Indian fires, fur trapping, hunting, fishing, land clearing, burning, tilling, draining, soil erosion, irrigation and, in more recent times, urbanization and industrialization with their attendant construction, water demands, and waste disposal — all have altered the natural environment. A drastic reduction in the number of native plant and animal species and their substitution with exotic animals and plants or native trees which normally grow farther north has produced a new environment (visual and structural) which is unrelated to the past.

The approach used in this appraisal was two-fold. The characteristic plant species and their natural groupings in the original forest ecosystems were documented, and then an appraisal was made of how Indian land use, wind, and fire influenced the distribution and composition of the forests. Second, with this documentation serving as an environmental benchmark, or point of historic departure, an evaluation was made of the separate and cumulative impact of agricultural practices and urbanization on the Study Area.

By scrutinizing environmental changes from a historic perspective — in this instance of almost two centuries — a point in time can be identified at which irreversible environmental changes were reached, leading to permanent alterations in the functioning of natural ecosystems. Once these changes are identified, those original environments viewed as useful for purposes of esthetics, water quality, recreation, scientific research and education can be rebuilt at least in part by working within the natural tendencies, or the potential, of the ecosystem. On the other hand, artificial or exotic plant and animal communities which operate counter to the natural tendencies of the environment and which require continual and/or expensive maintenance to ensure their survival can be allowed to revert.

The 1968 biosphere conference sponsored by United Nations Economic and Social Organization assumed that human society on a global, national, and regional scale must reach as soon as possible a harmonious balance — an environmental homeostasis — between human consumption and disposal, and an environmental structure viable under the pressures of population density. Hopefully the Haldimand-Norfolk area of Ontario may serve as an example of what can be done to achieve this homeostasis on a regional scale when future environmental quality is planned. This study as a historical scenario will document the chasm existing between an objective of homeostasis and the present condition of the terrestrial and aquatic ecosystems.

General Methodology

A general methodology had to be developed to enable the reconstruction as closely as possible of the ecosystem once characteristic of the Study Area. Information sources containing descriptions of the original animal and plant communities were analyzed. Then a comparison of the results with present remnants of those communities was made.

A historical reconstruction of the original forest communities began with the examination of the field notes and maps of the original surveys or those portions of the surveys available from the Ontario Department of Lands and Forests for all the townships in the Study Area. Unfortunately, no usable notes were available for the townships of Tuscarora, Brantford, Moulton, Canborough and that portion of East Oxford included in the Study Area.

Based on the surveyors' lot-by-lot notes in each township, the forest species were mapped separately for each township at a scale of 1:50,000. Then a composite or more generalized map at a scale of 1:100,000 was derived by combining forest types shown on the 1:50,000 maps (Map 4-1) and from examining the notes for those portions of townships lying on the periphery of the Study Area. Interpolation was done between concession lines unless obvious topographic breaks suggested an upland forest stand should be replaced by a lowland stand. The species observed were tallied on a matrix of species associations (see Appendix B). For example, if the notes indicated that hard maple, beech, and elm were found in that order for a particular survey lot, the three entries would be made on the Mh horizontal line with one occurance each for maple, beech, and elm in the vertical columns. This matrix demonstrated which tree species were associated in the original forest, thereby determining forest community structure. Both subclimax and climax forest communities and dry, mesic, and wet forest types became identifiable as ecological entities. Because there exist no quantitative studies from this time period to depict the interaction of the forest species, this system of tally and matrix was evolved partly from con-

versations with Dr. C. Heindenreich of York University and from an unpublished Bachelor's thesis of Mr. M. Clarke (1969) of the University of Waterloo.

Early diaries and historical sketches such as those of William Pope and de Galinée, as well as the historical sections of the conservation authority reports, were examined for observations as to what animals existed at the time of settlement compared to those now present. Furthermore, these diaries and historical sketches provided some understanding of the environmental factors, such as Indian fires, which presumably accounted for the great faunal variety and floristic richness in the early forests and oak plains.

In the field, the original concession lines were driven to compare the present remnant vegetation and animal populations with those described in the literature as found on the same site over 170 years ago. This site-by-site comparison allowed for making a visual appraisal of changes which had occurred and for discerning evidence of reproductive vigor and shifts in species composition of the remnant forests.

In addition, interviews with resource managers working in the Grand River and Big Creek watersheds provided valuable information on the recent trend in land management as it is related to the ecology of this landscape now dominated by man. Water quality records of the Ontario Water Resources Commission were examined to assess the possible impact of urban and industrial effluents on natural water bodies.

In total, the methodology can be characterized as quantitative in regard to the examination and mapping of forests from land survey records, but more generalized or qualitative in regard to the trends in land use, wildlife extinctions and introductions, and shifts in fish populations. Hopefully, this methodological approach has provided an overview of the major environmental thresholds exceeded over the past 170 years and of the potentialities existing for restoration of the environmental fabric as the next phase of land use — urbanization and industrialization — exerts its expected dominance.

Species Interactions in the Early 1800's and in 1957

As outlined in the previous section, a matrix of tree species, derived from surveyors' notebooks, was tallied for the townships shown in Appendix B. For these combined townships, the composite data include 4906 entries [Table 4-1 (a)]. The entries for each species were converted to percentages [Table 4-1 (b)]. Where two or more species were associated over 33 percent of the time, this somewhat arbitrary percentage was considered to represent a natural plant grouping.

Results taken from Table 4-1 (b) indicate that (reading horizontally) five associations occurred: 1) hard maple-beech-elm-basswood; 2) chestnut-pine; 3) pine-beech; 4) oak-pine; 5) hemlock-beech-white pine.

Plant communities which were dominated by single species were as follows: white cedar, willow, alder, tamarack, soft maple, black ash, butternut, walnut, and oak plains.

The landscape types — thickets, fires meadows, and windfalls — were also identified as separate landscape units.

Generally, on the basis of present knowledge concerning the upland forest communities, No. 1 (hard maple-beech-elm-basswood) and No. 5 (hemlock-beech-white pine) would be considered climax or near climax, while Nos. 2 and 4 (chestnut-pine and oak-pine) would be considered subclimax. No. 3 (pine-beech) was probably somewhat closer to a climax stand than Nos. 2 and 4 and may have represented a very stable forest association on lighter soils. Forests on wet sites tended to be either of conifer or hardwoods, *e.g.,* cedar or soft maple.

Few stands dominated by Carolinian forest species (tulip, poplar, magnolia, sassafrass, black gum, pawpaw, flowering dogwood, sycamore) were noted [Table 4-1 (a)]. Their combined frequency was only slightly over 1 percent (54 out of 4906). Stands dominated by walnut tended to be within a few miles of Lake Erie (Map 4-1). This tendency for the Carolinian species to be minor components of the total forest is a condition which still prevails.[1]

This overview of the forest species composition at the beginning of the 19th century can be compared to quantitative botanical studies for this same region done by Dr. Paul Maycock,[2] who studied undisturbed remnant stands. On those sites he identified as mesic, or moist, the three species having the highest importance values were hard maple, beech, and white elm. On dry sites, the four having the highest importance values were white oak, juniper, black oak, and white pine. On wet sites, the white elm, red maple, soft maple, and willow were the four species most commonly associated. These results are similar to those abstracted from my analysis of the surveyors' observations, especially for the mesic and dry sites. Because of this similarity, it is reasonable to assume that the original survey records demonstrate correctly the general ecological relationships between tree species, soils, drainage, and the assumed modifications of the landscape (fires, oak plains) by the Indians discussed later in this section.

Influence of Fire and Wind on Original Vegetation

The impact of wind on the native stands is evident from the generalized map (Map 4-1) which shows some windfallen timber in most townships. The amount of windfallen timber is especially great in the first concessions of Bayham and Walsingham Townships. Although it is hard to judge the total impact of wind on the mature forest, it is apparent from these maps that on occasion extensive tracts were toppled by wind. The scattered occurrence of thickets throughout much of the area suggests either high wind, which toppled the mature trees, or fire, or both, as significant environmental events.

Fire was identified specifically in three areas of Windham Township by the surveyor in 1797, although his notes suggest that a great deal more of the township's forest land recently had been burned. Two of these burned areas were on adjacent concession lines, numbers 8 and 9. Because they did not reach over to the neighboring

Table 4-1A/Occurrence of Various Forest Species in Surveyors' Notes, with Species on Vertical Column the One Mentioned First in the Entry

		Mh	Be	C	Pw	Ce	Ab	E	Bd	O	W	Ha	Ms	He	Al	Or	Wa	B	Ir
Maple, hard	Mh	416	297	2	65		1	156	156	136				1			3	2	4
Beech	Be	245	371	35	70		21	64	45	46		1	4	16		8	2		
Chestnut	C	1	4	29	12					8									
Pine, white	Pw	131	183	28	397			5	12	48			3	12		3		1	2
Cedar, white	Ce					23	8							2					
Ash, black	Ab	1	5			4	297	53	8	2	2	1	49	3	1				1
Elm	E	28	17		7		5	48	14										
Basswood	Bd	3	1				1	8	17										
Oak, sp.?	O	6	6	8	59			2	1	173							3		
Willow	W										13								
Hazel	Ha																		
Maple, soft	Ms		2				2	1					10		1				
Hemlock	He	2	33	3	29	2			2	5				80					
Alder	Al														5				
Oak, red	Or	5	4											1		8			
Walnut	Wa	1	1		1			2	1								13		
Birch	B		2					1					3					4	
Ironwood	Ir																		1
Hickory	Hi																		
Tamarack	Ta																		
Dogwood	Dg																		
Sassafrass	Sa																		
Butternut	Bu			1				2	1										
Sycamore	Sy							1											
Ash, white	Aw	2	2		1			4	3										
Cherry	Ch																		
Windfall	WF		2	1	6								1	1					
Thickets	T																		
Meadow	Md							2											
Oak Plains	Pn																		
Fire	Fi																		
Popple Aspen	Po				1					1									
Oak, Swamp	Os																		
Mixed Forest	Mi	11	9		2	1		2	4	11							10		
Oak, white	Ow	5	6		1									1		2			1
Ash, sp.?	Ash								8										
Plum	Plum																		

Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Po	Os	Mi	Ow	Ash	Plum	**Total**
2				1		5			5										1252
1						14		3	2										948
				3		1													58
2				2		4		6	9				1	10					859
									1						2				36
	2			1		3										1			434
				2		4	2												127
						2													32
	1			1		10							2			1			272
																			13
																			16
		1	1					6							1				165
																			5
1						3										3			25
									3							1			23
						1										1			12
																			1
	17																		17
				19	2	2	1												28
				1	1														3
				1		21													34
							1												1
	1							31	16										59
									11						1				12
										24									26
											89								89
												3							3
													4						6
1						1		1	3						242				298
																9			25
																	17		25
																		2	2
																			4906

land in Norwich Township, these fires were apparently small and self-contained. Early in the settlement period also, forest fires must have been extensive over some of the area. On at least one occasion in 1815 the Crown had to resurvey part of Walsingham Township, originally surveyed in 1795, to place new stakes in the ground because a ground fire hot enough to destroy the original stakes had burned an extensive wooded area in the southern concessions, numbers 2 to 5. Probably many such post-settlement fires resulted from the practice of burning trees and brush as the land was cleared.

The extreme diversity of the original forest indicated by these maps is surprising, since it is usual to assume that the primeval, or "virgin", forest was of uniform species composition and age. The patchwork pattern of forest types which emerges from this mapping cannot be satisfactorily explained by soil and moisture variation alone, although no doubt these two factors are important. It seems likely that wind and fire were important natural factors which, combined with soil and wetland effects, prevented climax forest stands from developing throughout much of the area and caused continual disturbance to the climax stands prior to white settlement.

In planning park, forestry, and open space uses, it would be advisable to assume that fire and wind will continue to affect remaining forest areas. Species such as white and bur oak, which can withstand ground fires, should be planted rather than stands of pines and spruce. Where choices exist, maple-beech woodlands should be avoided for park use if oak stands can be suitable replacements. Selective hardwood logging by taking a higher percentage of the total basal area of the stand than is usually done will favor oak regeneration, as opposed to regeneration of tolerant species (hard maple and beech).

Table Table 4-1B/Percentages of Species Occurring Together as Taken from the Original Surveyors' Notes, Computed from Table 4-1 (a).

	Mh	Be	C	Pw	Ab	E	Bd	O	He	Wa	Bu	Aw	Ms
Me	(100)	71	1	16	1	38	38	33	1	1	1	1	—
Be	66	(100)	9	19	6	17	12	15	4	1	—	4	1
C	3	14	(100)	41	—	—	—	28	—	—	10	3	—
Pw	33	46	7	(100)	—	1	3	13	3	—	1	1	1
Ab	1	1	—	—	(100)	18	3	1	1	—	1	1	16
E	58	35	—	15	10	(100)	29	—	—	—	4	8	—
Bd	18	6	—	—	6	47	(100)	—	—	—	—	12	—
O	3	3	5	34	—	1	1	(100)	—	2	1	6	—
He	2	41	3	36	—	—	2	6	(100)	—	—	—	—
Wa	8	8	—	8	—	15	8	8	—	(100)	—	—	—
Bu	—	—	5	—	—	10	5	—	—	—	(100)	10	—
Aw	10	10	—	5	—	19	14	—	—	—	5	(100)	—
Ms	—	20	—	—	20	10	—	—	—	—	—	—	(100)

[1] **These groups exclude those reciprocal relationships such as Be-Mh, E-Mh and Bd-E.**

Trends in Forest Use from Settlement to the Present

The census figures of the 16 townships in the Study Area, obtained from the *Otter Valley Conservation Report*[3] and *Big Creek Region Conservation Report,*[4] show that forests covered 75 percent of the land in 1851, 24 percent in 1891, and after 1911 fluctuated between 11 and 13 percent. Field checking of stands adjacent to the original survey lines demonstrated that logging (high-grading) and grazing have severely affected the viability of much of the presently existing 11 percent. In those portions of the Study Area where dairying is an important agricultural land use, grazing by cattle is especially severe on both upland and wetland forest sites (Figures 4-3 to 4-5). Furthermore, figures taken from the *Big Creek Region Conservation Report* along with those of Brantford Township from the *Grand Valley Conservation Report*[5] show that about 30 percent of the forest stands are affected adversely by grazing. Overall, then, when these grazed stands are subtracted from the 11 percent of the Study Area still in woodland, less than 8 percent of the area contains forest ecosystems which might be considered self-reproducing or viable systems able to respond to anticipated demands for recreation, forestry, or wildlife management.

In addition, many forest areas have suffered severely from the chestnut blight and more recently from Dutch elm disease. Since both chestnut and elm were major forest components on dry (chestnut) and mesic (elm) sites, this additional loss of woodland is indeed unfortunate. However, some of these mesic sites do offer opportunities for commercial black walnut production.

Reforestation

Although in the total Study Area forest plantations, dating from 1900 and from the 1930's, occupy a small percentage of the land, their visual impact far outweighs the percentage of the occupied land. The use of exotic scots pine, norway spruce, lombardy poplar in combination with non-indigenous red pine, jack pine, and white spruce (brought south of their original range which begins near Georgian Bay) suggests a wholesale adoption of northern Ontario forestry practices, originated in northern Europe, which work counter to the ecological, historical, and cultural realities of this region. Only the white pine stands can be considered appropriate to the region's ecology, history, and culture.

Field inspection of many of such plantations demonstrates that little conifer reproduction, with the exception of a small amount of white pine, is taking place within or on the periphery of these plantations. Rather these plantations are converting to stands dominated by native hardwoods. Within 50 to 75 years these stands will become predominately hardwood stands. In essence, then, not only is the visual character of the landscape homogen-

Figure 4-1/Large open-grown white oak in Charlotteville Township, old enough to have been in place when the surveyor for the Crown identified this line as "Oak Plain".

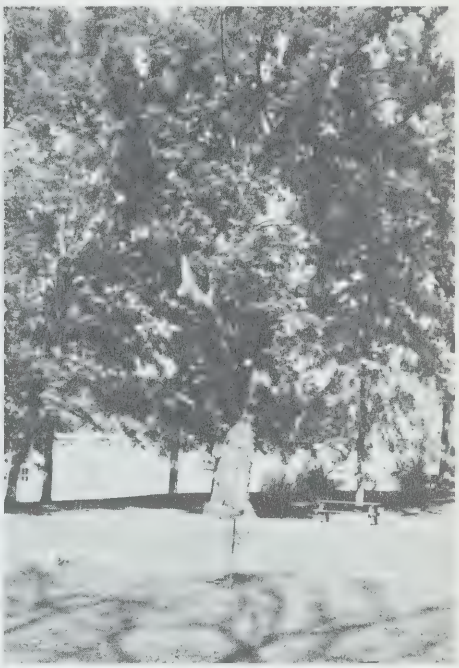

Figure 4-2/Lynwood Park, Simcoe, an original oak plain fenced by the original owner Mr. Campbell, then given to the town in 1902 for park use. The open-grown white oaks are probably well over 300 years old while forest-grown red oaks and white pine of a younger age are scattered throughout the park.

zed to conform to European-northern Ontario forestry concepts, but this crop of trees, planted at considerable cost and having limited market value, will be a single one; to maintain these stands a costly new planting program will have to be undertaken because of the inherent inability of these species to compete with native hardwoods. However, even though they are not reproducing, growth of the plantations is generally excellent even on very dry sandy sites originally occupied in the 1800's by oak plains, or oak savannah. Locally, ice damage to scots pine is significant near Lake Erie.

The use of hardwood stock for replanting is now receiving some attention in the field from the resource managers who were contacted. Originally extensive stands of walnut were located near Lake Erie on many survey lines (see maps of Walsingham, Walpole, Rainham Townships in Appendix B). In 1881, the Ontario Agricultural Commission[6] recommended walnut planting and estimated that, within 25 years on good sites at $50 per 1000 board feet, a landowner could expect a new crop valued at $1600 per acre. At today's market value of $1000 per 1000 board feet, the gross value would be 20 times more or $32,000 per acre. Since board feet incremental growth is faster after 25 years of age, theoretically, according to the Commission's figures, a stand could increase in annual value by more than $1250 per year per acre and yield within 75 years a per acre value of over $100,000. At today's market price of walnut, it is believed that $40,000 to $50,000 is a more realistic figure at maturity than the $100,000 figure. Considering the present land value of $150 to $2000 per acre, the potential of hardwood planting on private and public lands should be re-examined, especially in those areas which supported extensive mixed hardwood-walnut stands in 1800.

Relict Stands

It is astounding that south of a line from Hamilton to Grand Bend, Dr. Paul Maycock could find useful for scientific study only 131 forest stands of 10 acres or more in size which were being neither logged severely nor grazed.[7] In the Haldimand-Norfolk-Brant Study Area, only 24 such isolated pristine, or relict, forest units exist, according to his map. Since some of these areas are presently in public ownership, their management by competent ecologists for scientific purposes is possible. Present logging of these stands by foresters of the Ontario Department of Lands and Forests has caused considerable bitterness between various public and private groups interested in recreation and outdoor education, an unfortunate state of affairs. When those stands are gone, the best remnants of original southern Ontario ecosystems disappear with them. Any hope of understanding the complex relationships between the various plant and animal species upon which scientific forest and park management rests will be lost with them.

The Ecology of the Oak Plains

The occurence of oak plains in much of Charlotteville, Woodhouse, Windham, east Burford, Townsend, Oakland, and South Dumfries Townships is an interesting and colorful landscape form now lost as a distinct visual and ecological entity. Judging by early accounts re-

Figure 4-3/Accelerated erosion due to overgrazing by dairy cattle along a tributary of Otter Creek, South Norwich Township.

corded by Major R. Cuthbertson Muir in 1913, the plains were "... an open country, dotted here and there with groves of inferior black oak and the softer woods, but mostly covered in short grass and bushes".[8] Usually the surveyors' notes referred to them as white oak plains or oak plains (see Map 4-1).[9]

In a letter in *The History of the County of Brant* (1883), Captain Alexander Campbell, a friend of Joseph Brant, described the area around the Mohawk chief's home south of Brantford as "... Plains ... very extensive, a few trees here and there interspersed, and so thinly scattered as not to require any clearing, and hardly sufficient for the necessaries of the farmer".[10] From the same volume is a description of the plains in South Dumfries Township:

> Originally covered thickly with large oak trees. These had short thick trunks, with spreading boughs and foliage. Now the original oaks of forest growth, like pines and other trees which grew together in the bush, have their bough and foliage at the top, the presence of a boundless contiguity of trees not allowing their expansion laterally. Therefore, the conclusion is drawn that these 'oak openings' were a second growth succeeding to the original oak forest which had been burned by lightning or by the campfires of Indians; the latter cause seems most probable.[11]

Recent research supports the belief that the oak plains and their associated pine and popple thickets in North and South Dumfries Townships were caused by Indian fires.[12]

William Pope in 1834 described the oak plains west of Brantford as "... timber scattered in single trees and small patches in mostly oak. Indians were formerly accustomed to set fire to the brushwood in order to clear the land that grass might more freely grow which furnished plenty of food for deer. Thus these animals were enticed from all the surrounding forests".[13]

During the investigation of the original oak plains shown on Map 4-1, some very large open-grown oaks were discovered along the road in Charlotteville Township (Figure 4-1) and in the city of Simcoe (Lynnwood City Park, Figure 4-2. The latter contains many large open-grown white oaks, at least 300 years old, surrounded by younger white pine and red oak, perhaps 100 years of age. The visual appearance of this park is almost identical to the description of the oak plains in South Dumfries Township cited above. According to the historical sketches of the city of Simcoe,[14] this park was fenced and maintained as a nature preserve by Duncan Campbell at the time of settlement around 1805, and deeded to the city in 1902. Hence it is an authentic piece of the original oak plain ecosystem. Perhaps other relict stands of oak savannah remain either in pastures, parks, and burned woods, or along railway rights-of-way.

The likelihood that these oak plains were the result of periodic fires is reinforced by their ability today to support good forest stands and pine plantations. Also, in the account of the settlement of Long Point, oak grubs are mentioned.[15] The existence of grubs is evidence of a fire landscape where the oak was burned back, leaving the live root, or grub, which had to be removed laboriously by hand when the area was cleared for agriculture. Hence, it seems plausible that the pre-settlement southern Ontario landscape was in part an Indian fire-induced landscape.

Because oak savannahs are both attractive and ecologically durable landscapes able to sustain grazing and human activities, such as estate subdivisions and parks, their maintenance or restoration is compatible with an urban-industrial type of land use. Experimentally, it is important to study the ecological dynamics of this once extensive landscape type to see what factors, such as soil, climate, and fire, interacted to control the floristic composition and thereby the native animal composition.

The Impact of Cattle on Forest Floodplains

As stated earlier, grazing of forest affects a high percentage (30 percent) of the remaining stands in many townships. Besides the direct loss of

Figure 4-4/Severe streambank erosion, Fairchild Creek, Brant County.

uture forest resources and the unpro-ductive nature of forest pastureland rom the point of view of animal usbandry, the long-term environ-nental impact generated by this ignificant form of agricultural activity n Haldimand, Brant, and northwestern Norfolk Counties needs to be recog-nized (Figures 4-3 to 4-5).

High turbidity in streams of Haldi-nand County and the lower Grand River, visually evident eutrophication, nd severe bank erosion caused by rampling reveal a degrading and lerelict riverine landscape. Prompt neasures must be taken now to move attle out of the valley lands by erecting encing, constructing gravelled cattle rossings, and initiating replanting rograms. Otherwise, the increased un-off from road construction attendant pon urbanization will result in accel-rated erosion, siltation, smothering of sh spawning beds, and loss of marsh abitat. A few farms were seen where tream-bank fencing and planting were ncorporated into agricultural practices, producing both an environment resistant to heavy run-off and an attractive diversity satisfying to the eye (Figure 4-6). Floodplain control of grazing begun now can lead to immediate improvement in surface water quality and to establishment of the necessary floodplain control and recreation corridors needed in future urbanized areas.

Animal Ecology of The Study Area

No systematic accounts of animal abundance comparable to the documentation of forest vegetation from surveyors' notebooks are available for the Study Area. However, general accounts by missionaries, travelers, and settlers when combined with data of the vegetation surveys do supply some insight into the diversity of species and their relative abundance. Present-day knowledge of animal ecology can offer some insight into why so many species became extinct as settlement, hunting, and trapping destroyed their population structures and habitats, and offer clues as to how some of these may be re-introduced.

The mix of animals present in the 19th century can be segrated into: 1) forest animals (*e.g.,* grouse, marten, fisher, snowshoe hare); 2) forest-edge species (*e.g.,* quail, deer, elk, turkey); and 3) aquatic birds and mammals (*e.g.,* otter, beaver)—similar to present animal groupings. Following nearly 100 years of white settlement, the 89 percent reduction in forest areas (by 1900) and the extinction of so many animal species demonstrate dramatically the environmental disruption, primarily to the forest and aquatic species, which had occurred by this time. Some of the forest-edge species remain in low numbers today.

The forests and the shoreline of Lake Erie at the time of settlement abounded in game, judging by the description of hunting and fishing activities recorded in *Pioneer Sketches of Long Point Settlement*[16] and in the diary of de Galinée.[17] The variety of large game and their associated predators, of furbearers, of gallinaceous game birds, and of waterfowl attest to the variety of the productive forest and aquatic habitats. Large herds of what were assumed to be elk (100 roebucks and 50 to 60 hinds) were noted by de Galinée in the 1650's in the Black Creek area. In 1793 Major E. B. Littlehales described his trip through Burford Township with Joseph Brant: "I passed over some fine open plains, said to be frequented by immense herds of deer".[18]

Harrassment of the Long Point settlers by wolves and bears was

common[19] so that by June 1793 wolf bounty legislation was passed by the Council of Upper Canada.[20] Wolves were labelled "sylvan pests" in the South Dumfries Township even after land clearing had been long underway.[21] Only heavy deer and turkey populations would sustain what must have been a substantial wolf population. Bears were a continual nuisance to the settlers, consuming corn and killing sheep, calves, and pigs.[22] The final refuge for bears and wolves was the Walsingham swamp, where the last bear was killed in 1866.

Other carnivores, such as wildcats and wolverines, were also present at the time of settlement.[23] Dependent upon the forest habitat, these animals were eradicated as forest clearing advanced.

Large flocks of turkeys were mentioned by Captain Alexander Campbell during a hunt with Joseph Brant in Brant County in 1791.[24] At Turkey Point in 1793 the gobbling of these birds was cited as a significant auditory environmental feature.[25] In 1834, William Pope in his diary recorded turkey flocks west of Simcoe. With their disappearance by 1885, along with the passenger pigeon, the wilderness of Upper Canada was indeed gone. Waterfowl, as might be anticipated, were abundant in pioneer times along the Lake Erie marshes. Prairie grouse apparently occurred further west toward Sarnia, for no accounts were found which could be identified as referring specifically to prairie grouse. Conceivably the oak plains could have sustained sharp-tailed grouse.

Generally the causes for animal species extinction seem related to the disappearance of the forest as clearing proceeded for agriculture. For elk, however, the cause of extirpation was probably hunting pressure exerted by the Iroquois and Mississaugas since these animals were gone by 1750. The loss of forest species (moose, fisher, marten, wildcat, cougar, bear, wolf, wolverine, porcupine, beaver, otter, passenger pigeon, and turkey) would coincide with the 85 to 90 percent forest clearing which had been accomplished by 1900. Increases in quail, a forest-edge bird, would be expected at the mid-way point (*i.e.,* 1840-1850) as farm settlement was accomplished. Introduction of the pheasant and European hare as well as the invasion of the cottontail and coyote into the area have compensated, in a minor way, for the enormous loss in faunal diversity.

Figure 4-5/Nanticoke Creek, Haldimand County. Visually the water quality of this creek is poor, apparently due to turbidity and nutrient enrichment. Cattle are at least contributing factors if not the major reason for this poor water quality.

The outlook for the end of this century without management intervention, and assuming that the area is urbanized and industrialized, is for very limited wildlife resources. Small songbirds and a few game mammals as well as migratory waterfowl along Lake Erie are the usual animal species mix able to use such areas. Without a concerted effort to preserve the marshes along Lake Erie, the few remaining forests, and the roadside habitat and fence rows to encourage birds such as quail, the outlook is, to say the least, grim.

The present landscape of mixed forests providing mast (acorns), browse, and cover interspersed with corn and pasture land in the west and northern sections of the Study Area theoretically provides near optimum deer habitat. The much higher densities of deer on similar range at Long Point, in southern Michigan, northern Illinois, southwestern Wisconsin and Iowa indicate the potentially high big game suitability of the Study Area. Perhaps poaching, accidental death and/or predatory wild dogs are unduly depressing deer numbers on habitat that historically supported high densities. A research program to study these deer populations could determine present limiting factors and could define a management program to increase, if feasible, deer densities without incurring crop damage.

Changes in Fish Populations

The Grand River and Other Watersheds

The shift in fish populations of the Grand River and other watersheds in the Study Area and Lake Erie are indicative of profound deterioration of the aquatic ecosystem which has occurred in the last century and a half. In 1791 Captain Alexander Campbell, describing the Grand River near Joseph Brant's home, commented on the fine runs of fish: ". . . abundance of fish are caught here in certain seasons, particularly in spring, such as sturgeon, pike, pickeral, maskinonage, and others peculiar to this county . . . ."[26]

In Burford Township, with the destruction of the forests by agricultural development, ". . . the streams grow less; the brook trout and other fish, thirty year's ago (*i.e.,* 1853) so abundant in these creeks, have disappeared, poisoned, it is thought, by the sawdust from the mills".[27] No doubt the many water-powered mills caused significant fluctuations in the temperature and water chemistry during this settlement period. Today scattered trout populations exist in small portions of Whiteman's Creek, Big Creek, and Otter Creek.

That the present trout population on the Big Creek watershed has not changed in the past 15 to 20 years suggests that during this period the use of DDT on the tobacco crops in Norfolk County has not altered the food chains sufficiently, if at all, to affect the trout.[28] Occasional kills of fish do occur, however, because of dumping of industrial wastes and pesticides into the streams.[29]

The continued agricultural land reclamation in Norfolk County accomplished by ditching and forest clearing pose real difficulties for the survival of aquatic life. Farmers tend to cultivate right up to the ditch and thereby add silt and fertilizers directly to the stream. Coupled with the loss in forest cover, a greater run-off of low quality can be expected. With irrigation by removal of groundwater added to these other agricultural practices, some overall policy to balance agricultural uses with competing uses for water-based recreation needs to be evolved.

Figure 4-6/A well-vegetated streambank, actually a ditched stream, where cattle have been fenced out of the ditch, North Norwich Township near Zenda.

Lake Erie

In the last century at Turkey Point, sturgeon in abundance were clubbed along the beaches.[30] In more recent times from 1956, landings of all fish species from Lake Erie have shown a dramatic shift downward, particularly in such species as blue pike, walleye, lake herring, whitefish, and sauger which are now essentially lost.[31] Some of the so-called trash fish (those of less value for commercial and sports fishing), such as sheepshead, carp, yellow perch, and smelt, have taken their place.

Admittedly it is difficult, where changes in numbers and species of fish are concerned, to separate the effect of almost 200 years of fishing exploitation from the effect of water quality changes induced by agricultural practices, and urban and industrial waste.

However, the International Joint Commission reports substantial evidence for both increased algal populations and increased mineral content (sodium potassium, chloride, calcium, and sulphate) in Lake Erie for the period from 1910-1920 to the 1960's. Its report states: "The decline of lake herring, whitefish, and blue pike, all of which require low water temperatures, may well be associated with increasing oxygen depletion in the deep waters of the central and eastern basins."[32] In addition, the Commission suspects that the rocky and gravelly spawing grounds of these species may be covered by algal growths and an accumulation of organic debris, impairing reproduction. Recent high mercury levels in lake fish demonstrate how sensitive fish may be to minor alterations in water chemistry through the mechanism of mineral concentration in biological food chains. In all, the Commission's evidence demonstrates that urban and industrial pollution beginning at the turn of the century is the major cause of the shift to fish species of lower market value.

Summary and Recommendations

Analysis of the original forest composition in eastern Elgin, Norfolk, Brant, and Haldimand Counties demonstrated that heavy winds along Lake Erie, spot fires (perhaps from lightning), and extensive Indian fires from Turkey Point north to North Dumfries Township, as well as variations in topography and drainage, influenced the distribution and composition of forest types and resulted in a diversified forest cover. This diversity probably accounted for the variety and abundance of game animals at the time of settlement about 1800.

By 1900, 89 percent of the forests had been cleared. The animals characteristic of the forest, such as turkey, passenger pigeon, wolf, had disappeared or become extinct. The game species present today are a mixture of imported species and remnant populations of native species.

The original fisheries in the Grand River and Lake Erie were of excellent quality; today they are dominated by lower value fish, such as carp, suckers, perch and smelt, indicative of lower water quality. In April 1970, commercial fishing was suspended in Lake Erie because of mercury concentration in the fish. Some parts of the Big Creek watershed, however, still support good brook trout populations.

The scattered blocks of upland and lowland forests remaining (11 percent of total land area) are of potential esthetic and recreational value for an urban-industrial area or for a post-industrial society oriented toward leisure, if they are retained as landscape features and if destructive grazing by dairy cattle can be halted. The present use of wooded and grassed river valleys for grazing has resulted in severe deterioration of streambanks in much of Haldimand, Brant, and northwestern Norfolk County.

The historical overview provided by this chapter documents both the diversity (and indirectly suggests the beauty) of the original landscape and the drastic changes in the fauna and flora since settlement in the late 1790's. Until 1900 these changes were rapid; since that time the forest and aquatic ecosystems have been more slowly degraded or simplified. Projection forward another 200 years suggests total degradation of the natural systems will result unless a positive strategy can be adopted now. The intent of this chapter was not to document destruction caused by settlement, but to suggest a strategy which can arrest further degradation of the ecosystem and, hopefully, reverse or stabilize this process so that some ecological homeostasis can be achieved while time remains. Such a strategy is suggested in the following eleven recommendations, all of which are equally important.

1) The few scattered relict stands which have not been grazed or cut should be designated as historic sites or nature preserves. Their management should be removed from existing private and governmental agencies, and placed in the hands of ecologists working with some type of trust board composed of citizens, scholars, and government planners. Any required manipulation of these stands would be for scientific purposes controlled by the trust board, not for economic ones. Without the maintenance and study of these ecological benchmarks any future restorative work to the natural environment will be hampered.

2) Because the oak plains were once a dominant landscape feature throughout the center of the Study Area and north of Turkey Point, they merit restoration as part of the cultural heritage of the region. This might best be done on a 500-foot-wide strip along a scenic-historic parkway. The oak plains could be expanded to include other areas as time, manpower, experience and public acceptance are gained. Turkey Point, because of its significant water-fowl area and scenic attractions, might become the focal point of an oak plains park which could occupy a site overlooking Lake Erie. Hopefully, wild turkey, quail, deer, beaver, otter, porcupine, and possibly elk and prairie grouse, might be established in a near-wild or semi-domesticated state in the park; contiguous areas of conifers and hardwoods could serve as a source of food and cover.

3) Because present forest plantations of larch, jack pine, red pine, spruce, scots pine, and white pine to a lesser degree, are not reproducing but are converting naturally to hardwoods, it would seem logical to hasten this process by appropriate hardwood underplantings where forests are deemed necessary. A landscape dominated, as parts of the Study Area now are, by rows of conifers demonstrates its own kind of sterility — esthetic, cultural, historical, and natural.

4) Although in 1881 the economic value of black walnut was recognized clearly by the Agricultural Commission, few plantations were established and maintained by either government or farmers. It is still possible to correct this oversight by encouraging landowners and highway agencies to plant this species along roadsides or in greenbelts and by conversion of existing conifer plantations to walnut stands where the site is suitable. If 20-foot walnut plantings were made on each side of suitable rural roads, and pruned, the lumber value in 50 years could be almost $500,000 per mile, (500 trees times $1,000). The proceeds, if put in a revolving fund, would pay for further roadside plantings and establishment and maintenance of roadside parks.

5) Native to this area of Ontario are flowering dogwood, redbud, and tulip popular — three of the most beautiful spring flowering species of the Carolinian forest. Planted along roadsides, forest edges, in parks and around homes, these shrubs and trees could provide a unique visual experience comparable in tourist appeal to the apple blossoming in the Niagara Peninsula.

6) The original vegetation of the Lake Erie shoreline was highly diversified. If cottages are removed and public access re-established along the shoreline, this vegetation could be restored using the original vegetation maps and

soils as blueprints for restoration.

7) A crash program by the conservation authorities, the Departments of Agriculture and Food, and Lands and Forests, and the Ontario Water Resources Commission is vital to control the pollution of streams (silt, manure) caused by cattle-grazing along banks in the parts of the Study Area where dairying is located. Until such upstream control is achieved, it is foolish to spend millions of dollars of public money on reservoirs for recreation or for pollution abatement such as now are planned by at least two of the authorities. If the various land use agencies are unable to acquire stream-bank easement of the few acres per farm required to control bank erosion, then the Ontario Water Resources Commission, using its power for water pollution abatement, can order the offending farmers to implement appropriate land use practices. This would reduce the numbers of coliform bacteria and silt to acceptable levels. The "mini-shed" demonstration program of soil and land conservation practices now begun by the Grand River Conservation Authority should be expanded immediately.

8) Hydrological research and water resource planning are required now to avoid the severe conflicts which will arise between the recreational and urban demands for water and the tobacco fields. Impact of further agricultural drains, highways, and irrigation use on water quality and stream life is potentially severe.

9) The scattered forests that remain are often at the rear of the farm because each settler was required to clear the forest from the front of his farm and along the rights-of-way. If high-speed roads are developed along the present concession lines and low-speed scenic drives planned as a separate road grid using these rear forest areas for a backdrop, a visual impression of the "original" Ontario can be created. Since these woodlots are small, the scenic road should wind between the woodlots and along their periphery, and not through them. A winding road would of necessity be low-speed.

10) The planting of sugar maple along roadsides, common at the turn of the century, seems to be a lost tradition. The many rows of hard maples forming a canopy over the road produce a strong visual experience especially in fall. Since these trees, now near maturity, are dying and are being removed for road widening, planting should be re-established where safety permits. Shrubs such as viburnum, dogwood, sassafrass, and sumac can be introduced as a border for maples or walnuts to achieve a variety in texture and color. Almost 100 native chestnut (*Castanea)* sprouts and trees still grow along sideroads where stands were recorded by the original surveyors; these plants should be protected from spraying or cutting in the hope that eventually a genetically resistant strain may develop by sexual propagation. The largest trees found had a diameter of 4 inches and a height of 30 feet; some had burrs (nuts), and a few showed no evidence of past or present blight.

11) An investment strategy to produce economic, social and ecological "profit" using public and private funds should be developed with a view to encouraging new landowners to renovate deteriorated valley lands, protect grazed forest areas, and reforest eroded farmlands. Many of these historically abused areas might be restored with recreational use in mind and thereby be upgraded over the long term. By allowing and encouraging controlled severances for the specific purpose of land resource renovation and by operating in a free market sense, a large flow of capital and human involvement in the process of land rebuilding may be possible. Without a positive government planning strategy for such renovations, the probable final result will be only more long term environmental deterioration as an urban dominated environment replaces an agricultural one.

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Introduction

Water is the prime requisite for plant, animal and human life. Its availability in a useable form defines the limits within which human activities can be carried on. The growth of populated areas, the production of food and fiber, the maintenance of transportation and other services, the operation of many industries, recreation and amenities depend upon available suitable water supplies. The economic growth of any area depends upon a satisfactory water supply. Therefore, the development of water resources should be based on a thorough knowledge of the quantity and quality of any water available.

This chapter summarizes in a broad way water resource information currently available for the Haldimand-Norfolk environmental region. No attempt has been made to present a complete record of the hydrologic information, which is voluminous, nor has any detailed analysis been made of such information. This examination presents a broad-view water resource inventory and estimates the present use of water in the region. It also outlines certain problems and possible solutions for future water distribution.

Hydrologic Processes

In its unending cycle between the clouds and the surface of the earth, water follows many courses. Precipitation, in the form of rain, snow, hail, sleet, dew and frost is the immediate source of all water on the earth's surface and underground. The precipitation falling on a drainage basin may leave this basin in two forms: as a vapor or as a liquid.

When a rainstorm occurs, part of the rainfall remains on vegetation and eventually evaporates; this is termed an interception loss. Part of the rainfall evaporates from the surface of the soil, or it may enter the soil to increase the soil moisture, and eventually evaporate or be transpired through the vegetation. Another part of the rainfall may percolate down into the groundwater reservoir and raise the water table. Part of the rainfall may also infiltrate into the soil and flow along just under the surface and reappear again as subsurface flow. Finally, a part of the rainfall moves overland to the main channels as stream flow. The entire hydrologic process is complex, many of the portions depending very much upon the character of the particular watershed. The aim of a hydrologist is to forecast a runoff hydrograph for a particular area or watershed from a rainfall pattern or histogram. Such techniques will estimate the peak flows from a stream, to aid in flood prediction and damage estimation; low flows may be estimated for predicting water supply or sewage dilution. Similar procedures will forecast the amount of storage needed for water supply or recreation needs.

A few of the natural processes important to water resources will be discussed briefly here.

Precipitation

Precipitation over the Study Area averages 33.7 inches annually. The long term average monthly precipitation is relatively evenly distributed as shown in Table 5-1. The distribution of mean annual snowfall is also shown in Table 5-1. Snowfall is important since it is a water resource in temporary storage; if captured for beneficial use it represents a large volume of water.

Figure 5-1 shows that total precipitation in the region varies from year to year and similarly by periods, for which wet and dry tendencies may persist. The figure was prepared by computing the World Meteorological Organization 1931-60 standard normal period long-term average of 35.62 inches. This amount was subtracted algebraically from each annual amount to obtain a departure from the mean. The departures were then summed and plotted in Figure 5-1.

Table 5-1/Normal Depth of Precipitation at Simcoe

Month	Mean Monthly Precipitation (inches)	Mean Monthly Snowfall (inches)
January	3.15	13.6
February	2.91	14.0
March	3.28	10.8
April	3.17	2.0
May	2.81	trace
June	2.54	0.0
July	2.93	0.0
August	2.90	0.0
September	2.98	0.0
October	3.01	0.2
November	3.01	5.9
December	2.93	11.3
Total	35.62	57.8

The figure shows that "minus departures" from the long term average predominated, and that a deficiency of 21.41 inches has been recorded. From 1935 to 1945 and from 1957 to 1966 there is no definite tendency as precipitation amounts were both above and below the average. From 1931 to 1935 and from 1945 to 1948 minus departures took place and major recovery occurred between 1948 and 1958. We appear to be in a period of deficient rainfall again.

The distribution of precipitation varies from month to month and from year to year. Rainfall, which is the most important form, also varies during a storm, creating non-uniform distribution which often results in local stream runoff not experienced by the entire region. A study of these variations should be made for the region so that potential flood hazards and conversely drought probability may be assessed as an aid

Figure 5-1/Precipitation Departures from Normal Simcoe, Ontario. 1931-1968.

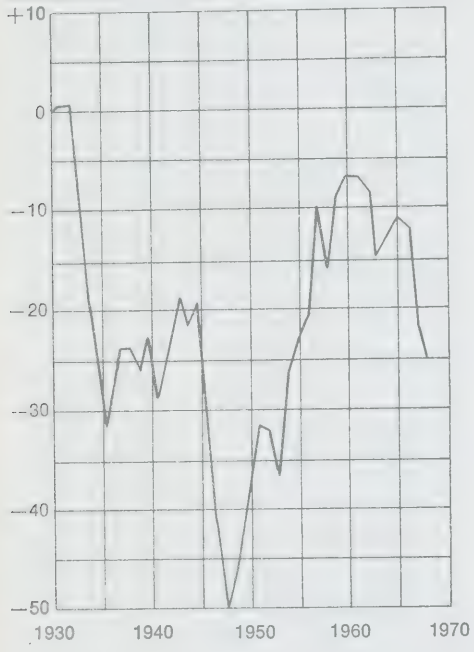
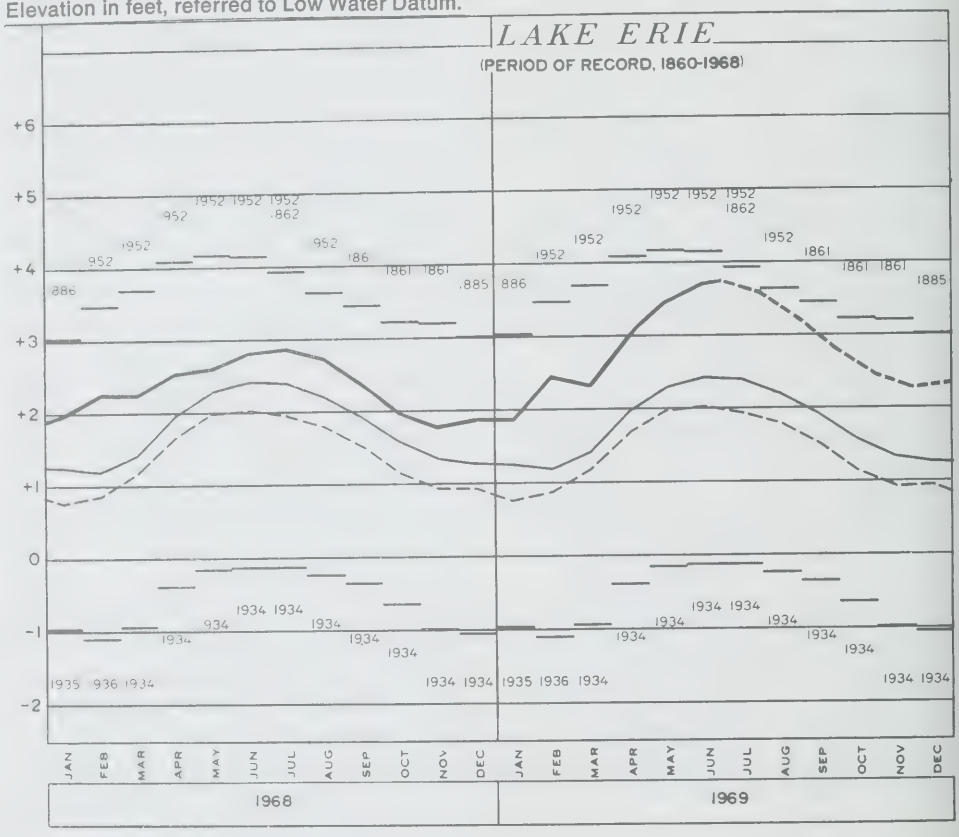


Figure 5-2/Maximum, Mean and Minimum Levels of Lake Erie. Source: U.S. Corps of Engineers.

Elevation in feet, referred to Low Water Datum.



to forecasting water needs for the region.

Evapotranspiration

Water loss occurs through transpiration from vegetation and by direct evaporation to the atmosphere. These processes are usually combined into a term named evapotranspiration. The actual mean annual evapotranspiration in the area is about 21 inches. When this amount is subtracted from the mean annual precipitation, it produces an average water surplus of 12.6 inches or 386,500 million gallons.

The importance of the above value lies in the fact that all water uses for the area which are to be met from precipitation must be contained within this value.

Lake Erie

Lake Erie forms over 100 miles of frontage for the Study Area. The lake is no more than 30 miles from the most distant point in the area. It is therefore an extremely important water resource and must be considered carefully.

Lake Erie is the shallowest of the Great Lakes with a mean depth of 90 feet; the maximum depth is about 210 feet. The lake is 241 miles long and 57 miles wide at the widest point. The total drainage area above the head of the lake is 230,415 square miles. The high quality of the water entering the Detroit River is seriously impaired in that reach. However, the quality of Lake Erie is satisfactory for many purposes and varies over the lake.

Lake Levels

Strong winds cause the lake level to fluctuate widely. A continuing east wind causes the lake to drop below the low water datum (568.6) making it impossible to move shipping in some parts. This situation usually lasts only one or two days. Maximum daily variations of 9 feet have been recorded at the east end of the lake. Lake Erie is also subject to seiches of irregular amount and duration caused by the wind changing and releasing the water "piled up" at the end of the lake creating an oscillation of the water surface.

Long term seasonal and annual changes in water level also occur. These variations are primarily dependent upon precipitation on the Great Lakes watershed above. The maximum monthly recorded elevation was 572.8 IGLD (1955) in May 1952; the minimum monthly elevation was 566.8 in February 1936. Normally the mean annual fluctuation is 2 feet.

The fluctuations of the lake are important when considering the location and depth of water intakes and pumping facilities. Figure 5-2 shows the maxi-

mum, mean and minimum annual fluctuations for the lake. Water level is currently very high. High lake levels cause serious erosion problems resulting in collapse of retaining walls. Docks must be moved and beaches are flooded. Planning should always recognize the cycle of lake levels so that important structures are not built only to be damaged at a later time. Lake levels are not subject to man's control.

Groundwater

Water not removed by surface runoff or evaporation enters the soil and becomes a part of the soil moisture. When the soil moisture amount becomes greater than the soil is capable of retaining, the balance of the water sinks to the water table and recharges the groundwater supply. Little recharge takes place during the summer months because of the high vegetative evaporative demand. The yield of any penetrating well depends on the composition of the water-bearing stratum, or aquifers, and the transmissibility of its constituent materials. The recharge of the aquifer is affected by the permeability of the surface layers. For example, in Haldimand County the fine textured topsoil is a substantial barrier to aquifer recharge. Although swamps are frequently looked upon as recharge areas, in fact they are discharge areas. The coarse grained soils of Norfolk County facilitate recharge, and there are usually moderate quantities of groundwater available under such soils.

A continuous hydrograph of a groundwater level observation well (OWRC No. 5) at Kohler, near Cayuga, shows that a sharp decrease in groundwater level begins in May and continues until the evapotranspiration demand lessens in the fall, at which time groundwater recharge begins. Generally, little addition to groundwater takes place during the winter when the soil is frozen. While recharge is a seasonal phenomenon, the time and quantity of recharge varies from year to year owing to variations in the weather pattern.

Examination of the hydrography also shows that minimum groundwater levels have been maintained, but the wide fluctuations have narrowed in recent years. An analysis of this and other wells in the region would be necessary to state definitely if the groundwater level is undergoing a regional decrease. The opinion of local residents appears to support the premise that no such trend is taking place on a general basis.

Stream Flow

Stream flow is a residual; it is water left over after the heavy demands of evapotranspiration upon the rainfall have been met. It has two components—part flows just under the surface and reappears as springs or seeps for days and weeks after a storm, the other component is direct runoff which supplies most of the volume of stream flow in flood periods.

Stream flow for many rivers and creeks in the area is recorded by the Inland Waters Branch, Water Survey of Canada. Records of monthly stream flow of the Grand River at Brantford show that peak flows occur in March due to the release of snow-melt; minimum flows occur from May until January.

Minimum-flow data are important in water use planning, for these flows limit the usefulness of a stream for diluting sewage and industrial wastes, and supplying the demands for irrigation, municipal water supply, recreation and other uses. A special study of low-flow duration curves which would give the frequency of such low-flows should be made for the larger streams. The length-of-flow records for most streams in the area are rather short for such an approach but available statistical techniques would make it a useful exercise. Such studies are outside the terms of this study.

Man has not yet learned to control rainfall, although he can change the runoff-producing characteristics of a drainage area by means of ditches, urban development and type of vegetation. Most activities tend to increase the rate of runoff rather than conserve the water. Large swamps tend to sustain the base flow for many of the streams in the area. Particularly valuable swamps are the Burford swamp which contributes to the base flow of Big Creek; Oakland swamp which contributes to the base flow of McKenzie Creek; and Canborough swamp which contributes to Oswego Creek.

These large swamps should be retained as natural preserves to maintain the present ecology and water retention capabilities of the area.

In water resource planning the maximum-minimum flow for each year and the annual runoff or water yield are important. Maximum flows are a measure of flood potential and minimum flows influence limitations on beneficial stream use. Annual water yield reflects the total outflow from an area. At the present time there are 21 surface water stations located in the region. Stream gauge locations with watershed boundaries are shown in Map 5-1. Table 5-2 gives details as to the characteristics and records for each of these watersheds.

For the streams shown in Table 5-2 the mean flow distribution throughout the year, as a percentage of total annual flow, may be approximated by the following distribution:

October	5%
November	6%
December	7%
January	7%
February	11%
March	21%
April	20%
May	10%
June	4%
July	3%
August	3%
September	3%

It was estimated previously that the surface water surplus is about 386,500 million gallons or 1,160,000 acre-feet. About 62 percent is spring runoff presently unavailable to the region.

There are no continuous flow records for some large streams in the area. However, the total discharge from selected streams for the year 1966 shows that a large volume of water is available to the area if it could be beneficially used.

Table 5-2/Summary of Hydrometric and Stream Flow Data in the Region

Station Number	Year Begun	Stream Name	Gauge Location	Drainage Area (sq. mi.)	Discharge Maximum (cfs)	Discharge Minimum (cfs)	Mean Annual (cfs)	Inches Depth on Area
02GB001	1947	Grand River	Brantford	2,010	47,800	65	1,800	12.1
02GC005	1954	North Creek	Delhi	21	1,000	0	19.4	12.6
02GC004	1948	Big Otter Cr.	Vienna	269	7,410	10.8	258	12.9
02GC006	1955	Big Creek	Delhi	140	5,230	7.1	120	11.6
02GC011	1963	Big Creek	Kelvin	55	1,910	0	35.2	8.7
02GC007	1955	Big Creek	Walsingham	228	8,500	33.8	198	11.8
02GC017	1964	Big Otter Cr.	Otterville	36	1,070	0	29.4	11.1
02GC010	1960	Big Otter Cr.	Tillsonburg	132	5,160	1.4	96.3	9.9
02GC013	1963	Dedrich Cr.	Port Rowan	28	603	1.5	25.1	12.1
02GB008	1961	Horner Cr.	Mount Vernon	148	2,980	6.8	99.6	8.8
02GB006	1953	Horner Cr.	Princeton	58	1,950	0	56.8	13.3
02GB009	1961	Kenny Creek	Burford	35.5	1,050	0	25.6	9.8
02GC015	1963	Little Otter Cr.	Straffordville	40	593	6.2	41.2	14.0
02GB010	1961	McKenzie Cr.	Caledonia	66	1,110	0	38.6	8.0
02GB011	1964	Mt. Pleasant Cr.	Burtch	11.5	210	1.5	6.2	7.3
02GC016	1964	South Otter Cr.	Port Burwell	42	1,310	0	38.9	12.6
02GC021	1963	Venison Creek	Walsingham	26.4	1,580	5.9	39.6	20.3
02GC014	1963	Young Creek	Vittoria	22.7	468	1.4	24.9	14.9
02GB007	1964	Fairchild Cr.	Brantford	139	2,690	0.6	95.4	9.3
02GC012	1963	Patterson Cr.	Simcoe	17.8	314	5.2	21.0	16.2
02GC008	1957	Lynn River	Simcoe	55	1,880	2.7	46.5	11.5

All streams drain to Lake Erie. The Grand River is the major contributor of surface water although its drainage area within the region is not large.

Map 5-1 shows that a portion of the surface drainage pattern of Haldimand County is toward the Welland River. The main drainage stream is the Grand River with 11 creeks emptying into it and nine into Lake Erie. In Brant County, Horner, McKenkie, Boston, Mount Pleasant, and Fairchild Creeks and the Nith River flow into the Grand River. With Big Otter Creek on the west edge of Norfolk County forming the regional boundary, the major streams of the county are Big Creek and the Lynn River.

Stream	Acre-Feet
Grand River	1,300,000
Otter Creek	165,000
Big Creek	132,800
Lynn River	33,490
South Otter Creek	28,160
Dedrich Creek	18,140
Young Creek	18,000

Lake Erie

Lake Erie is the present source of water for only a small portion of the study region. While the supply of good water is virtually unlimited, there is only a small development of this resource. The present major development is the Ontario Water Resources Commission regional pumping and treatment plant in Dunn Township which supplies two industries with 10 million gallons per day (gpd), plus the town of Dunnville. Local residents in the township do not use this facility. The intake is 48 inches in diameter. The capacity of the plant is 20.3 million gpd.

In Norfolk County the municipalities of Port Rowan and Port Dover take water from the lake. In Haldimand County the town of Jarvis uses a 9.5-mile pipeline to take about 0.1 million gpd. In addition to these larger users, water is taken from the lake by a few irrigators and numerous cottage developments. The total water use from this source in the Study Area is probably about 4 billion gallons of which 90 percent is returned directly to the lake after use.

The quality of the lake along the Study Area is good. The water becomes turbid during the spring and when wind affects both the turbidity and pollution levels at the water intakes. Generally only partial water treatment is required to make it satisfactory for domestic use.

Groundwater

Water-bearing strata, called aquifers, may be divided into three classes: shallow unconsolidated deposits, deep unconsolidated deposits, and consolidated rocks. Consolidated rock aquifers are limestone and dolomite, shale and sandstone. The largest quantities of water are to be found in the secondary solution channels in the rock.

The shallow unconsolidated deposits are widely used for agricultural and suburban uses. While these are considered to be shallow if less than 100 feet deep, the largest number of wells are to be found within 30 feet of the surface.

The deep unconsolidated deposits of interest to this study are usually bands of coarse sand and gravel found in old glacial channels or in a thin layer lying between the overburden and the bedrock.

The quality of groundwater is controlled by the geology, topography and climate of a region. In this region the rainfall is plentiful and the topography favorable but in most instances the quantity of water yielded is small.

Table 5-3/Summary of Water-Well Drilling Data by Number of Wells and County, 1947-1963.

	Brant	Haldimand	Norfolk
Total wells drilled	819	933	1,543
In overburden	419	121	1,108
In bedrock	375	782	370
Dry holes and unclassified	25	30	65
Quality of water found			
Fresh	723	707	1,291
Sulphur	68	180	150
Mineral	14	12	9
Salt	1	1	0
Use of water			
Domestic and stock	613	790	1,070
Industrial	15	17	29
Commercial	29	22	45
Irrigation	63	4	191
Public supply	58	54	73
Test hole	19	0	97

Water-Bearing Formations

The unconsolidated materials of the region consist of gravel, sands and clay of varying thickness. The sand areas of Norfolk produce adequate water of good quality through small diameter sand points, dug wells or ponds. As the thickness of the sand decreases the quantity of water available becomes less and summer shortages develop. In Haldimand County the clay surface soil seriously impedes infiltration and the permeability is so low that the yield of shallow wells in this area is small.

Aquifers in bedrock are the main source for drilled wells in areas where overburden aquifers are lacking. Generally, the water is of poor quality, being highly mineralized, and, in the gas well area, contaminated with hydrogen sulphide. It is difficult to generalize in this region but the Devonian rocks tend to supply potable water while the Silurian rocks are mineralized.

In northern parts of Brant County, drilled wells supply adequate water of good quality. Water is difficult to find in the southern portions of the county.

Table 5-3 is a summary of water-well drilling data for the region and shows the distribution of sources of groundwater in the three counties. Eighty-five percent of the drilled wells in Haldimand, 33 percent in Norfolk and 46 percent in Brant are found in the bedrock. (Note: The table does not include dug wells.)

Yield of Wells

One method of evaluating the adequacy of groundwater supplies and the behavior of aquifers is by observation wells. One of these wells was discussed previously. However, the Ontario Water Resources Commission maintains a record from others in the region. There are two in Haldimand, one in Brant and three in Norfolk. To evaluate the water resources adequately, additional wells are required in the other potential strata not tested by the existing wells. These are necessary to point out areas of excessive pumping or where aquifer recharge is below normal.

Dug wells are common throughout the region. In Haldimand County where the population is largely rural and widely and uniformly spread, dug wells are the chief source of fresh water which in that area is confined to the upper few feet of the overburden. The dug well is satisfactory where demand is not high and where the water is obtained at depths of less than 20 feet. The well depends upon its large

Table 5-4/Comparison of Water from Lake Erie and the Grand River

Constituent in ppm	Lake Erie (Peacock Point)	Grand River (Paris)	OWRC Recommendation*
Hardness ($CaCO_3$)	135	266	
Alkalinity ($CaCO_3$)	102	197	
Chlorides (Cl)	24	28	250 max.
Iron (Fe)	0.40	2.8	0.30 max.
pH	8.0	7.9	6.7 - 8.5
Turbidity (units)	16.7	5.7	1 max.
Color (units)	10	—	5 max.

*Drinking water standard, OWRC.

diameter (30-42 inches) to store a relatively large volume of water which seeps in slowly over a long period of time.

In many instances a dug well cannot be obtained or is not dependable; therefore, cisterns are constructed to store roof water. Cisterns are a source of potable water for a large portion of south Brant and Haldimand. During the dry months, haulage contractors replenish the cisterns since the roof surface area is seldom large enough to collect sufficient water for domestic purposes.

Dug wells and sand points are common in the deltaic sands covering one-quarter of Brant and Norfolk. These produce a good supply of water at shallow depth. Single well points may yield 60 gallons per minute (gpm) and when combined are usually adequate for most uses.

It is very difficult to estimate the probable yield of new wells from the surface because of the wide range in the ability of an aquifer to yield water of a specified quantity or quality.

Groundwater is a resource renewable by recharge from rainfall, and potential yield of water to wells depends upon the permeability and thickness of the water-bearing strata.

Map 5-2 shows in a general way the availability of groundwater in the Study Area. This map was prepared from an analysis of water-well records submitted to the Ontario Water Resources Commission by well drilling contractors. The map does not include shallow dug wells.

In the Study Area 3 to 5 gpm, adequate for domestic use, can be obtained from drilled wells at depths ranging from 40 to 100 feet. It appears that the deeper the well, the greater the probability that the water will be unpalatable because of mineral or sulphur contaminants. It is chiefly for this reason that other sources are used by the local population.

Substantial flows of good quality water may be obtained from wells in Norfolk and northern Brant. No well in Haldimand yields more than 83 gpm. Practically all wells over 50 gpm are sulphurous.

It is estimated that probably not more than 50 percent of the total groundwater is available through wells.

Ponds are a source of groundwater but will be discussed in detail in the section on irrigation.

Surface Water

Surface water in the region does not constitute a major source for domestic use. It was shown previously that the surface water resource is large but varies throughout the year. To make this a useable water resource of dependable character, a program of reservoir development would have to be undertaken.

Surface water is used by irrigators along many of the streams in the sandy areas and by livestock owners in other areas. Both of these will be discussed in detail later.

Delhi uses North Creek as its primary source of water. The towns of Caledonia and Cayuga use wells along the Grand River. However, the chief user of surface water is the city of Brantford which in 1968 pumped 7.72 million gpd from the Grand River. In addition, a number of industries in the city and township take water from the river using their own facilities.

An indication of the quality of water from the Grand River as compared with water from Lake Erie is shown in Table 5-4. Both sources are suitable for domestic use with complete treatment.

Present Use of Water in The Region

Agricultural Uses

Agricultural Drainage

Land drainage practice, both urban and rural, redistributes water and is therefore of interest in this study. Drainage ditches provide a source of water in some areas. Some irrigators have placed dams in the ditches to conserve water for irrigation. This is an illegal and dangerous practice.

The drainage of agricultural land is effected by the construction of major outlet drainage works which are usually improvements to the natural drainage system of the area. In smaller watersheds these may also be closed drains. Once an outlet system is available, the individual farmer may construct a surface and/or subsurface drainage system on his farm if the natural soil drainage is impaired. Chapter 7, Agricultural Land Use, shows the location of areas of poorly and imperfectly drained land in the region.

The results of a survey of the drainage needs of the region, made in 1964,[1] are presented in Table 5-5. The table shows that the drainage hazard is severe and must be improved if the future agriculture is to prosper in the region.

A survey of farmer opinion was taken by the Farm Statistics Branch of the Ontario Department of Agriculture and Food in 1967 to ascertain their future drainage. The results of the survey are as follows: in Brant 279 farmers planned to install tile drains in the next three years on 30,508 acres; for Haldimand the values are 134 on 48,731 acres and in Norfolk 771 farmers wish to drain 39,900 acres. These forecasts cannot physically be met. However, they do show the opinion of farmers at this time and the fact that they recognize there is a problem.

Agricultural land drainage activity is found on the fine-textured soil east of Dunnville in Moulton and Canborough, primarily for vegetable crops. A large expanse of undulating Haldimand clay covers much of Haldimand County and the eastern portion of Norfolk County. Some successful local attempts with tile underdrainage have taken place on a limited basis to date. There is a real problem to be overcome with this soil. There are few satisfactory drainage outlets in Haldimand County as they have not been regularly maintained in the past.

The Drainage Act 1962 which provides for the construction of outlet drains is based on the premise that a majority of persons in an area may dictate a land use practice which injuriously affects minority owners. This conflict of land use cannot be resolved great need for a review of government by regional institutions. There is a policy on water management practice followed by individuals. This policy should take the form of rural zoning based upon land capability.

In recent years a large number of open and closed drains have been constructed in the coarse-textured Wauseon sandy loam soils used for the production of tobacco. These drains have lowered the water table locally. The Wauseon soil is a marginal soil for tobacco. It is wet. This is due to a high permanent water table in its topographic position, not because of clay beneath at shallow

Table 5-5/Agricultural Drainage Needs of the Region

	Brant	Haldimand	Norfolk
Total land area (acres)	269,440	312,320	405,760
Impaired drainage	155,000	253,380	124,500
Impaired (%)	57	81	31
Tile drains needed (acres)	68,250	53,152	126,244
Area now tiled (acres)	14,670	2,474	42,379
Now tiled (%)	21	5	33
No outlet available (%)	15	23	14

Table 5-6/Drains Constructed Under the Drainage Act.

	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
Norfolk						
Open drains (ft.)	166,998	92,233	60,065	48,553	36,290	96,885
Closed drains (ft.)	7,207	32,795	11,495	2,600	6,115	16,545
Number of Drains Constructed						
Charlotteville	3	1	0	2	0	1
Houghton	1	0	4	0	0	2
Middleton	4	0	3	1	1	2
Walsingham N.	2	5	2	1	2	0
Walsingham S.	0	0	0	0	0	1
Townsend	2	3	2	0	1	0
Windham	6	6	4	1	3	3
Haldimand						
Open drains (ft.)	10,370	7,375	0	6,374	9,725	0
Closed drains (ft.)	0	0	0	0	0	0
Number of Drains Constructed						
Sherbrooke	2	0	0	1	1	0
Dunn	0	0	0	1	0	0
Moulton	0	1	0	0	0	0
Brant						
Open drains (ft.)	69,815	46,118	0	12,800	6,700	8,265
Closed drains (ft.)	10,816	500	15,108	0	1,575	5,130
Number of Drains Constructed						
Burford	6	3	3	1	1	2

Table 5-7/Tile Drainage Loans Under the Drainage Act.

	1962	1963	1964	1965	1966	1967	1968
Norfolk							
N. Walsingham	1	1	1			1	
S. Walsingham		1	2	4	9	4	7
Townsend	4	5	4	3	5		3
Windham						2	1
Charlotteville						4	1
Houghton							3
Haldimand							
Canborough							
Brant							
Burford				1		1	
S. Dumfries					1	1	

Table 5-8/Water Sources for Domestic and Livestock Use (Percent).

Source of Water Used	Brant		Haldimand		Norfolk	
	Home	Stock	Home	Stock	Home	Stock
Drilled well	28	39	32	79	39	31
Bored well	3	3	1	2	5	3
Dug well	45	31	32	10	31	15
Cistern	28	7	71	6	13	3
Sand point	12	11	—	—	23	13
Stream, etc.	3	17	1	10	3	11
Dugout pond	4	14	4	27	5	12
Public utility	1	1	1	—	2	1
Springs	3	5	1	2	1	1
Same source used for home & stock	72		38		72	
Sulphur problem with water	12		33		12	

Table 5-9/Daily Water Use by Livestock in the Region (gallons per day).

	Brant	Haldimand	Norfolk	Otter	Total
Horses	13,800	10,800	24,200	8,800	57,600
Milk cows	380,000	597,000	244,000	241,000	1,472,000
Other cattle	300,000	361,000	203,300	162,000	1,026,300
Pigs	48,400	48,200	33,900	38,200	168,700
Sheep	6,200	8,900	2,500	100	17,700
Poultry	176,000	30,500	30,800	12,500	249,800
Turkeys	8,800	11,700	15,200	8,400	44,100
Total	933,200	1,068,100	553,900	471,000	3,026,200

depths as in some soils in the region. Systematic tile drains with fiberglass covering materials are used for these soils. The present cost for these installations is about 20 cents per foot. In most of the region, about 85 percent of the systems are of a random nature with lateral drains 1000 to 2500 feet in length. Many are used with the dairy and canning industries.

Tables 5-6 and 5-7 are presented here to indicate the townships where the work of drainage improvement is progressing, and the relative magnitude of the work.

Agriculture is an essential industry in the region. It is therefore important that its growth and progress be maintained. Agriculture consumes the greatest amount of water in the area. Much of this is used by the crops and grass in the area where it falls as rain, and could be considered not available for any other use. Even though large amounts of water are used in this way much more could be used to increase crop production through an expanded irrigation program, if economically feasible.

The water uses in agriculture are numerous and only the more significant ones will be discussed here.

Rural Home Use

The present rural home need not differ from an urban home as far as the use of water is concerned. In the absence of data relative to per capita daily consumption on farms, estimates were used here equivalent to uses in small villages. Under these circumstances 100 percent is consumed since waste water is not usually returned to the source, although it may eventually get there.

Farm homes still carrying water from a well or other source average about 5 gallons per capita per day, those with piped water for kitchen use about 20 gallons per capita per day, and those with complete water systems may use 50 gallons per capita per day. Based upon an expansion of census statistics (1969) the number of dwellings without running water in Brant is estimated to be five percent, for Haldimand 15 percent and for Norfolk 10 percent. The rural population of the counties for this phase of the study was Brant 21,416; Haldimand 18,693 and Norfolk 31,547.

Based on the above assumptions there are 35,000 gallons of water per day carried into rural homes and 3,240,000 gallons per day are pumped into homes via a water system. The total use of water in rural homes is therefore 3.28 million gallons per day.

The number of homes with improved water systems will increase in the future. If water is available, the per capita use will also increase, probably at a yearly rate of 1 gallon per capita per day.

The primary source of water for

Table 5-10/Distribution of Water Supply Sources for Irrigation.

Township	Permit OWRC mg	Type of Source (%) Dug-out Pond	Stream	On-Stream Pond	By-Pass Pond	Sand Point	Lake Erie	Well	Pit
Brant									
Dumfries S.	.647								
Burford	7.124	81	13	0	2	2			
Oakland	1.381	72	9	12	2	2			
Brantford	—	64	18	6	6	5			
Onandaga	.315								
Norfolk									
Charlotteville	62.798	65	14	12	—	—		2	
Houghton	49.252	51	16	23	4	1	5		
Middleton	73.382	57	19	15	5	1			
Townsend	35.672	82	6	9	0	—		1	
Walsingham N.	91.140	47	28	17	3	1			
Walsingham S.	—	53	21	22	3	—			
Windham	105.096	75	12	3	3	—			
Woodhouse	10.066	47	29	11	3	3		5	
Elgin									
Bayham	67.217	29	39	23	6	—	3		
Malahide	40.914	51	22	24	—	—			
Oxford									
Dereham	.005	26	21	42	—	—			11
Norwich N.	7.006	42	31	—	15	8			4
Norwich S.	67.730	53	47	16	8	—			

rural use in the region is the shallow dug well. The relative distribution of this and other water sources is shown in Table 5-8.

Livestock Water Use

The quantity of water consumed by livestock may be determined by using published census (1966) livestock numbers and the rate of water use per day as published by Hore (1966). Rural use of water for the farm home and for livestock is small when compared to some other agricultural uses.

Table 5-9 shows the distribution of use of water by livestock in the region. The present estimated daily use for this purpose is 3.03 million gpd. If the dairy industry should expand by 10 percent and the beef, swine, and poultry industries expand by 50 percent in the future, probably other sources of water will be required.

Irrigation

Supplemental irrigation has developed in the region since 1950. Most industrial users of water do not consume large quantities since over 85 percent is returned to the source after use. Irrigation, on the other hand, consumes about 90 percent of the water applied and there is no way of economizing for optimum use. The limiting factor for its increased use is water availability.

Irrigation of tobacco began about 1950 and irrigated acreage increased rapidly because of dry summers until 1956.[2] With an improved rainfall distribution, the rapid demand for irrigation levelled off to a modest increase of five percent annually.

Irrigation systems require a large capital investment, probably averaging $4500, depending upon the water supply, type and location. Nearly all existing systems use portable aluminum pipe to distribute the water. System capacities average 550 gallons per minute but range between 300 and 1200. Systems are designed and sold on the basis of applying about 1 inch of water to an area in five days. The actual on-farm operation of systems in the area differs substantially from this criterion and results in much wasted water.

The 1969 acreage of tobacco in the Study Area was 76,000 acres. Best estimates are that 85 percent, or 65,000 acres, receive some irrigation water; the number of farms irrigated is about 2400 for an average of 27 acres per farm. The irrigated acreage depends upon the tobacco allotment each year.

The chief crop irrigated is flue-cured tobacco. A few other field and vegetable crops are irrigated but represent a very small acreage. Using the census (1960), values for irrigated acreage in the Study Area are as follows:

Norfolk	57,000
Haldimand	350
Brant	15,000
Oxford	4,000
Elgin	4,000
Total	80,350

These total estimates are very likely on the high side of the actual acreages.

There are several methods of estimating the volume of water used for irrigation. One involves using OWRC's records of registered water-taking applications for irrigation. As the permitted amount is not a good guide to what is actually used, one researcher assumed the amount actually used was 50 percent of the daily volume permitted for seven days of irrigation (Sibul, 1969). Based upon this approach and the permit data in column 2 of Table 5-10, the volume of water used for irrigation purposes annually would be 2030 mg.

Growers do not follow a regular irrigation schedule based on weather observations. The actual number of irrigations is normally two but will vary from one to three in most years. Irrigations at the Delhi Experimental Farm are shown in Table 5-11. These follow current practice in the region. The depth of water applied is usually based, by the grower, on the number of hours per lateral set and may vary from one-half inch to one and one-half inches with an average of about 1 inch. Since the irrigated acreage per farm is 27, then, based upon two irrigations per year, about 54 acre-inches of water per farm are applied annually. Based upon 2400 farms this is 3500 mg of water for agricultural irrigation. The soil is coarse grained and does not hold a large depth of water. A drought probability study for the region which would be useful for irrigation planning is beyond the limits of this study.

Studies in Ohio have shown that the irrigation of golf courses uses more water than the irrigation of all farms, nurseries and greenhouses in the state.[3] An exhaustive search was not made to locate all golf courses in the Haldimand-Norfolk-Brant area or to separate those that use irrigation water extensively. A list of known clubs is given below. The current practice is to apply 4 inches per month for three months at a rate of about 300 gpm per nine holes. The present use for this purpose is estimated to be 900 mg. This will be increased substantially with large-scale development of the region.

Table 5-11/Actual Water Applied, Delhi Experimental Farm.

	June		July		August		
Year	Date	Inches	Date	Inches	Date	Inches	Total Appli
1956	23	0.53	7	0.78			2.81
			26	1.50			
1957	21	0.53	30	1.50			2.03
1958			18	1.31	1	1.82	
					19	1.82	4.95
1959	13	0.35	2	0.78	5	1.82	
	20	0.53	11	1.04			
			19	1.31			5.83
1960			5	0.78			
			12	1.04			
			25	1.50			3.32
1961			9	0.78			
			20	1.31			2.09
1962			1	0.78	3	1.82	
			9	1.04			3.64
1963	2	1.25					1.25
1964				No records			
1965	28	0.53	5	0.78			1.31
1966				No irrigation			
1967				No irrigation			
1968			12	1.20			2.40
			22	1.20			
1969			12	0.90	18	0.90	1.80

The following are golf and country clubs in the Study Area:
Ava Golf Club, Brantford
Arrowdale Golf Club, Brantford
Brantford Golf Club, Brantford
North Ridge Golf Club, Brantford
Lakeside Park Golf Club, Port Dover
Dunnville Golf Club, Dunnville
Delhi Golf and Country Club, Delhi
Turkey Point Golf Club
Norfolk Golf Club, Simcoe
Paris Golf Club, Paris

Ponds have proved to be an inexpensive way of increasing the agricultural water supply and many have been built since 1950 for irrigation purposes. In the sandy areas these dugout ponds are, in effect, just large wells as they are dug below the water table. Some are very large, up to 600 feet long by 75 feet wide in areas where groundwater recovery is poor. The average depth is 12 feet. The estimated cost is $450 per acre-foot of water. Many are financed under the capital grants program of the Ontario Department of Agriculture and Food.

Table 5-10 gives the distribution of water sources for irrigation purposes in the region. Dugout ponds fed by groundwater are the most important source in the sandy tobacco soils of the area. Other major sources, such as well points and on- and off-stream ponds, receive water from groundwater sources or low stream flow. In the sandy soils precipitation is absorbed quickly and the groundwater level is sustained. In certain areas where irrigation demands are concentrated and overtax the groundwater, local deficiencies occur from time to time in prolonged dry weather.

In Haldimand County and other areas of predominantly clay soil, the infiltration rate of the soil is low and rainfall does not substantially contribute to the groundwater as a source. Many dugout ponds in the area use spring surface runoff as a source of water. In the heavily eroded areas near the lake, the gullies are dammed to form

onds. These ponds are primarily for tock water, and usually just meet the 000 square feet minimum size required r eligibility in the capital grant rogram.

The tobacco acreage may decline the future but with such a favorable limate and such valuable land, any hange will probably be toward fruit and egetables which also require large mounts of irrigation water. Therefore, nless some higher priority use evelops for the water, the use of irriga- on water will probably continue at the me rate. Some economies could be fected with greater control of irriga- on practices.

praying and Transplanting

ater is used as a carrier in spraying emical pesticides and fertilizers on elds and fruit trees. The actual volume water used for this purpose has not een determined, since a tree census as not available. However, an estimate the volume of need may be based the following acreages:

	Brant	Haldimand	Norfolk
getable crops	12,089	960	5,915
ple trees	636	89	2,757
uit trees	226	46	799
eenhouses (sq. ft.)	245,386	128,580	644,617

From the above acreages and eenhouse area it is estimated water e for these purposes is 225 mg per ar. The application is not uniformly read throughout the year.

Based upon the above analysis, e total annual use of water in the al area of the region may be mmarized as follows:

mestic use	1,200 mg
estock use	1,100 mg
gation	3,500 mg
lf courses	900 mg
ray water	225 mg
Total	6,925 mg

e above figure represents only 1.8 rcent of the surplus water of the ion.

Table 5-12/Municipal Water Supply Data for Towns over 1,000.

Municipality	Population	Source of Water Supply	Average Quantity Used (mgd.)
Brantford	61,008	Grand River	7.72
Simcoe	10,138	wells — 4	1.00
Tillsonburg	6,550	wells — 5	.66
Paris	6,428	wells — 3	.60
Dunnville	5,279	Lake Erie	1.02
Delhi	3,696	North Creek	.40
Port Dover	3,288	Lake Erie	.85
Caledonia	2,944	wells — 3	.26
Waterford	2,460	wells — 16	.25
Hagersville	2,222	wells — 2	.17
Norwich	1,705	wells	.12
Cayuga	1,039	Grand River	.12

Urban Uses

The water supplied by public systems not only provides for domestic uses but also for a considerable amount of industrial, commercial and miscellaneous uses. The common method of evaluating water use in a region is to multiply the per capita consumption by the human population. This procedure suffers from the disadvantage that it cannot take into account influences which future technological and social changes may exert on the water use pattern.

Urban Home Use

Domestic use is greatly influenced by a variety of factors; for example, air temperature (lawn watering); behavioral patterns (waste and shower time); economic position (number of water-using facilities).

In 1968, the city of Brantford, the largest urban user in the region, pumped 2,825,550,000 gallons of water for all purposes. About 36 percent of this volume was for domestic use which is 45 gallons per capita per day whereas the total per capita average use was 126.54 gpd. The maximum daily pumpage is approximately 1.5 times the daily average for most years.

There are 12 public water supply systems in populated centers over 1,000. These systems serve approximately 110,000 people or about two-thirds of the total population of the region. Based on 50 gallons per capita per day as an average domestic use for water, the total domestic use is 5,500,000 gallons per day. About one-third of the systems use groundwater as a source; the balance use water from either the Grand River or Lake Erie. Table 5-12 is a summary of the municipal water supply data for the urban centers. There are a number of privately owned water systems serving groups of individuals in the region. Many of these serve cottage developments along Lake Erie. They have no impact on regional water use as they use the lake as the source of water and capacities are small.

The total taking of water by municipal systems serving population centers over 1,000 is 13.17 million gpd. Of this amount 7.84 or 60 percent is taken from the Grand River. About 14 percent is taken from Lake Erie and 26 percent from groundwater.

Industrial

Water use by commercial establishments is difficult to estimate since the amount is usually included in the total volume used by a municipality. Exact amounts could be obtained from an

analysis of the public utilities commission contract records for each municipality but were not deemed to be necessary for this study.

The volume of industrial water required by industries varies greatly. Some industries use very little; others, such as steam generating plants, meat packing plants, canneries and creameries, require large quantities. A dependable adequate supply is necessary.

One of the largest and most important industrial users in the Study Area will be the Ontario Hydro generating station at Nanticoke which will require water for condensing steam and cooling. The plant will take 860 million gpd from Lake Erie and return it at an increased temperature. However, although it will use a great deal of water, it will consume very little.

Many other industries use water in large quantities for cooling. The Electric Reduction Company and Sherbrooke Metallurgical Company in Dunn Township, for example, which use about 5 million gpd for this purpose. The many food industries in the region also use large volumes of water in product processing.

Industrial use of water is frequently estimated as 54 percent for cooling purposes, 32 percent for processing, 9 percent for boiler feed, 6 percent for sanitation and cleaning and 4 percent unclassified. Some water is re-used for other purposes.

Most industries in the region obtain water from the municipalities. However, many are supplied from privately owned systems. Industrial use of water is increasing; about 95 percent of the water used is returned to the surface or groundwater resource after use. The city of Brantford industrial water use represents 50 percent of the total daily pumpage.

A few grist mills in the area still use water for power; their right of water use in a legal sense is still important.

Flood Problems

The maximum mean daily discharge recorded since gauges were installed is noted in Table 5-2. Floods have occurred from time to time; however, in the past the affected land has been mostly agricultural. Urban flood protection has not been a problem since much of the developed land is located above the flood plain.

In Brantford flood problems occur only after the discharge of the Grand River exceeds 39,000 cubic feet per second. For a "regional flood" to occur, the discharge would probably have to be 110,000 cubic feet per second. Severe damage could then occur.

Floods associated with spring break-up and ice jams have been a problem to urban areas on the Lynn River at Simcoe, Otter Creek at Vienna and Tillsonburg, and at Selkirk on Stoney Creek.

Restrictions on the use of flood plains for urban development should be encouraged through proper zoning for some compatible use such as recreation.

Waste Dilution

Stream flow is mainly considered for its waste dilution although some value is placed on it for urban water supply, fish and wildlife habitat, and recreation. These uses are not compatible; therefore, all water-borne wastes should receive a high degree of treatment prior to discharge into a stream. A sewer use bylaw should be adopted to control the quality of the discharge that industries contribute to the treatment plant. An expansion of existing anti-pollution centers is needed and new centers must be built where none now exist.

Integration of Water Supply and Water Demand

The economy of an area is closely related to its water resources. The principal uses of water in the Study Area are for agriculture, private domestic, industry, municipal water supply, waste disposal and recreation.

Agriculture

Agricultural uses and rural domestic uses depend primarily on the groundwater resources of the region for their supply. The present groundwater availability is good except in Haldimand and south Brant where low yield and poor quality limit use. In these two areas, surface sources are used when available. Rural dwellers depend on individual water supplies. Some farmers have experienced extreme difficulty in securing enough water for their domestic requirements, many having to buy and haul water.

A 1969 survey of feed lots in the region (each lot holding over 150 head of livestock) showed there were five in Haldimand, 11 in Norfolk and 14 in Brant. One large operation houses 400 heifers and 400 pigs; another has 900 pigs on feed. The heavy livestock concentrations, in addition to being a potential pollution problem, require substantial amounts of dependable water of good quality. This type of agricultural operation will become common if water is available.

The present use of water on the farms in the area is approximately evenly divided about 56 percent domestic and 44 percent for livestock use on a volume basis. It is expected that the domestic use will increase at about 2 percent per year because of improvements in living standards. Livestock water use will probably not increase greatly. Unless some form of regional distribution system can make water available at a reasonable cost to individual farms, it is unlikely that the present groundwater supplies are sufficient to supply increased water to concentrations of livestock.

It seems likely that agricultural use of water in the future will continue to depend primarily upon groundwater. Since agriculture will continue to be important in the region the industrial

nd urban use of groundwater should be ontrolled so that the agricultural ıdustry is not deprived of its only conomic source of water. New emands on groundwater should not be ncouraged without a thorough inves- gation and evaluation of its effect on xisting uses and requirements. As a orollary, individual septic tanks should e retained as the primary sewage isposal medium in rural areas.

Agricultural crops are subject to ıe vagaries of the weather so that rigation of tobacco, fruit and vege- ables in Norfolk and Brant is essential. dequate supplies of water for this urpose appear to be available for the resent and future uses from the surface nd groundwater resources near at and. Because of extremely low stream ow during critical drought periods ependence on surface sources for this urpose is an economic hazard. The eriods of limited stream flow make it ıandatory that any consumptive use e in the public interest.

rban and Industrial

lunicipal water supplies are somewhat ifferent from private agricultural and omestic water-taking, and they are ıore critical. There are no reservoir tes in the region for storage of larger olumes of water for urban use. The ritical conditions developing in some rban centers have stimulated planning or new water sources, primarily those f the Grand River or the Great Lakes.

Two-thirds of the population of the egion are served by public waterworks ystems and receive safe water through upervised production and distribution acilities. About 26 percent of the opulation is served by groundwater; ıe larger urban centers use surface ources.

egional Urban Water Supply

ne MacLaren report[4] on the regional ater supply for the lower Grand valley roposed that a 36-inch pipeline be onstructed from Peacock Point on Lake rie to Brantford city and township via arvis, Hagersville, Caledonia and ayuga. The precise route was not entified and would depend upon conomic and geologic factors.

A 1966 OWRC report on the Middle Grand also pointed out an immediate need to augment the water supply of the Kitchener-Waterloo area and offered a pipeline solution to the problem. Both reports are based on a rather static growth of all other population centers en route where generally existing facilities are satisfactory for present needs.

The major problem of the Brantford-Kitchener-Waterloo area is not water supply but the capacity of the Grand River to receive waste treatment plant effluent without exceeding acceptable levels of pollution. The augmented 273-day flow of the river in the driest time is estimated at 295 million gpd when the West Montrose dam system is built. The volume should be adequate for water supply purposes if the future pollution of the river can be controlled.

The city of Brantford undertook a major groundwater test drilling program in an effort to augment its water supply but without success. Only minimal supplies could be located at close range and these would interfere with existing shallow wells. Other centers, such as Simcoe, could augment their ground-water supply from surface sources but the cost of treatment would be sub-santially higher than at present.

The best major urban regional location, from a water availability point of view, is logically within the Simcoe-Port Dover-Jarvis triangle. These centers have the nuclei of systems which could be expanded to form part of an urban water distribution system based upon the Ontario Hydro water intake at Nanticoke and water from Lake Erie. This system may be joined to, or form a part of, an aqueduct system to the Brantford-Kitchener-Waterloo area if economically feasible. Water from this system would not be distri-buted to the rural areas because distribution costs would be high for such small individual uses. The dis-tribution should be controlled by the OWRC or by some regional public utility body which would replace the individual commissions now in the larger towns and villages.

The distribution of water should be coupled closely, in an administrative way, with anti-pollution centers of adequate capacity which must also be constructed. The same commission or utility should handle this problem on a regional basis. The possibility of a single processing center on the lake should be investigated.

The smaller communities have municipal water systems but rely on septic tank systems for waste disposal. These are very unsatisfactory, having resulted in severe local pollution in practically every community in the region.

Urban communities require a dependable supply of water. This is not to be found locally in stream flow or groundwater if there is to be any growth in population or water use. As urban use should not compete with other uses, the alternative is the lake.

Summary and Recommendations

Hydrologic Processes

1) Water resources are renewable and non-destructible. Therefore, the total physical volume of water is a constant and an average dependable supply can be assured with a high degree of certainty. Changes in the hydrologic cycle cause variations of a temporary nature which can be solved by adequate storage facilities.

2) Rainfall in the Study Area is presently less than the long-term average.

3) A study of the rainfall variability for the region, using probability techniques, would be useful for future planning.

4) The water surplus for the Study Area is 386,500 million gallons; however, 62 percent is lost through spring runoff.

5) Since water supply and sewage disposal are critical during low flow periods in streams a probability analysis of these streams should be made as soon as adequate data become available. Existing records may be correlated with nearby streams with longer records.

Regional Water Occurrence

6) Lake Erie and the Grand River are convenient sources of surface water in the region.

7) Surface water supplies other than those mentioned in (6) vary considerably during the year and are therefore not dependable for most uses. The region has a good drainage pattern.

8) Groundwater is found throughout the region but varies in certain parts of the Study Area. The OWRC should build more groundwater observation wells to ensure that observations are made in each geologic formation.

Regional Water Inventory

9) Lake Erie contains an unlimited supply of water of good quality.

10) Present annual use of water from Lake Erie is 4 billion gallons.

11) Groundwater supply in Norfolk and most of Brant is good to excellent, but in eastern and southern Brant and all of Haldimand is fair to poor.

12) Deep wells and high yielding wells in the region tend to be mineralized or contain sulphur, to a degree which renders the water non-potable in some areas.

13) Not more than 50 percent of the total groundwater is available through wells.

14) Although unused water may be considered wasted, care must be taken not to deplete unused reserves.

15) Surface water is not a major resource in the region for domestic use but is of major importance in the irrigation of crops. In certain portions of Haldimand and Brant Counties this resource is used for domestic purposes but is rather undependable. Potable water is frequently purchased to supplement the supply during the summer months.

16) Water from the Grand River is not a significant source for domestic use in the Study Area.

Regional Use of Water

17) Improvement of existing agricultural land through land drainage is a major need in the area, particularly in the fine-grained soils.

18) A program of major drainage outlet construction is required in Haldimand County if agriculture is to be improved and up-graded.

19) Drainage of Waseon soils for tobacco-growing should be discouraged.

20) Present rural domestic use of water is 3.28 million gpd. This rate of use will probably remain static since the smaller number of farms in the future will be offset by higher per unit use rates.

21) The primary source of water for domestic purposes is shallow wells.

22) Livestock water use in the region is 3.03 million gallons daily. This is about the maximum possible with present water sources.

23) Irrigation growth in the area is about 5 percent annually.

24) Irrigation consumes 90 percent of the water applied.

25) About 3500 million gallons of water are used for agricultural irrigation and applied to 80,000 acres.

26) Golf courses use about 900 million gallons of water per year.

27) The climate of the area is favorable to most crops and any reduction in tobacco production will probably be replaced by fruit and vegetables. This change will make no significant difference to the quantity of irrigation water used in the area for agricultural production.

28) Dugout ponds are a good source of irrigation water and cost about $450 per acre-foot of water.

29) Water use for spraying and greenhouses is 225 million gallons per year.

30) Total use of water in rural areas is 6925 million gallons annually.

31) Two-thirds of the population in the region are served by 12 public water supply systems. Their daily rate of use is 13.17 million gallons (60 percent from the Grand River, 14 percent from Lake Erie and 25 percent from groundwater).

32) Urban domestic use is 5.5 million gpd. Since commercial use is not separated in total pumpage it is included with industrial use at 7.67 million gpd.

33) Ontario Hydro will use 860 million gpd from Lake Erie.

Integration of Water Supply and Demand

34) Water is a natural monopoly; therefore, increased demand must be met by a public agency.

35) An amalgamation of services is needed. This could best be achieved through the OWRC taking control of the actual operation of the water and sewerage needs for the region. This involves both the collection and treatment of sewage, and the treatment and distribution of water.

36) Solid waste should be disposed of on a regional basis also.

37) A regional water distribution system is required for the area of Haldimand County west of the Grand River. This system should form a part of the major aqueduct system to the middle Grand region which should be planned to serve only the larger communities along the route.

38) The water requirements of the middle Grand region must be considered at the same time as aqueducts are planned for the lower Grand region since the same facilities should serve both areas.

39) A scientifically research-based population projection is a top priority need for actual water resource planning for the region since increased supplies of water mean increased unit costs.

40) The water supply problem can be

Footnotes/References

expected to contribute to higher water supply costs.
41) Water services and anti-pollution centers should be constructed prior to any future residential or industrial development in the area. Interim developments should be planned with a view to integration into the future large scale utility network for the area.
42) More efficient use should be made of water by reducing leakage, wastage and consumptive uses so that per capita use remains stable or is reduced.
43) The highest priority on groundwater should be assigned to rural domestic and agricultural uses.
44) The importance of groundwater to the area economy indicates a need for more rigid control by the OWRC to maintain existing static levels and to control the level of groundwater pollution.
45) Industrial use of water in the region is over 60 percent of the total used. Therefore, the rate structure for water charges should be based upon capital cost and use of facilities rather than upon political considerations.
46) About 90 percent of all urban water pumped is returned as surface water impaired in quality. Anti-pollution centers of adequate capacity should be constructed to overcome this problem. Effluent quality should be of a high standard.
47) Municipal and industrial sewage plants should provide secondary and tertiary treatment of all wastes.
48) Reservoir sites are not available for large urban water storages.
49) Demands for water will increase and costs will rise to bring forth additional supplies.
50) Flood plain development should be restricted to prevent flood damage. Compatible uses such as recreation should be considered.
51) Solid waste disposal is truly an environmental scourge and new methods of compaction and incineration should be practised.

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Introduction

"Although separate and distinct, two of our principal objectives are the provision of the best possible environment for our people and, at the same time, the creation and maintenance of an atmosphere which will encourage economic growth and development throughout the province."[1]

This "best possible environment" can be assured only if sizable blocks of natural areas having strategic value, both in quality and in location, are preserved for posterity. For the Haldimand-Norfolk Study Area the objective of the forest land use appraisal was to identify *present* and *potential* natural areas which should be preserved and maintained in perpetuity for the people, not only of the region, but of the whole province.

To this end, all the land in the Study Area (including neighboring parts of Brant, Oxford and Elgin Counties) was evaluated for its potential as forest, marsh and other natural vegetation multiple-use areas.

The approach used was that of ecological land use planning, an approach which is based on the knowledge of relationships between units of the non-living environment and the series of living communities they support.

Ecology deals with two types of production systems:
a) the *biotic ecosystem* which deals with the biological production of plant and animal communities;
b) the *human ecosystem* which deals with the total geographic production including biological, physiographic, artifact and societal production.

Because of the specific control which the non-living environment has upon production, it is essential to recognize types of physiographic units, their potential, and the degree to which the various communities are able to use this potential. Understanding the environmental interrelationships within space and time provides the basis for predicting the results of land-use adjustments and the degree to which the natural landscapes of the past will be able to survive the pressures of the future. This use of integrated units of non-living (physiographic) and living environments to measure comparative changes in the total production system is one of the features which distinguishes land-use ecology from many other types of ecology.

Accordingly, the Study Area was divided into 18 natural landscape units so that changes in their use by human communities might be studied on an integrated multiple-use basis.

A generalized appraisal of the potential of all land in the Study Area provided the backdrop for the development of strategic areas. Tracts of existing forest properties and other natural areas were analyzed in some detail to determine their relative importance in the present and future economy of the area.

The relationship between vegetation and physiography (landform, climate and soil) was studied on the most productive areas to determine those features which would assist in locating additional areas which, though undeveloped, have a high potential to provide the additional acreage of multiple-use natural areas that will be required for the anticipated population.

The Role of Forest and Other Natural Vegetation in Regional Development

Multiple-Use Natural Areas

The Need for Natural Areas

A major goal in planning the harmonic development of a region is that of providing for an adequate supply of clean air, clean water and all the other amenities which the natural environment can provide to enrich the meaning and enjoyment of human life. Thus a major planning objective is to designate for acquisition and protection natural areas which, under multiple-use management, produce the complex of scientific, cultural, esthetic and spiritual benefits which accrue when human communities have ample opportunity to observe, study, and become a part of, natural and semi-natural biotic communities.

Open space areas, such as golf courses and the common city park, are limited in scope and naturalness. Only from the more natural and unique landscape areas can man derive the full benefits of identifying with his whole environment.

The objective of reserving natural areas has been well stated in the preamble to Act No. S176 of the State of Indiana:

As part of the continuing growth of the population and the development of the economy of the State of Indiana it is necessary and desirable that areas of unusual natural significance be set aside and preserved for the benefit of present and future generations before they have been destroyed for once destroyed they cannot be wholly restored. Such areas are irreplaceable as laboratories for scientific research, as reservoirs of natural materials not all of the uses of which are now known, as habitats for plant and animal species and biotic communities whose diversity enriches the meaning and enjoyment of human life, as living museums where people may observe natural biotic and environmental systems of the earth and the interdependence of all forms of life, and as reminders of the vital dependence of the health of the human community upon the health of the natural communities of which it is an inseparable part. It is essential to the people of the State of Indiana that they retain the opportunities to maintain close contact with such living communities and environmental systems of the earth and to benefit from the scientific, esthetic, cultural and spiritual values they possess. It is therefore the public policy of the State of Indiana that a registry of such areas be established and maintained by the department, that such areas be acquired and preserved, and individuals, both public

and private, be encouraged to set aside such areas for the common benefit of the people of present and future generations.[2]

In summary, the main goal in reserving multiple-use natural areas is to preserve and maintain for man's use those slightly modified natural ecosystems which represent his heritage.

The Nature of Multiple-Use Natural Areas

Natural areas are non-farm non-urban areas supporting forest, marsh and other wildland vegetation.

Multiple use is the use of an area for two or more major uses under a single management program.

A natural area is a pattern of biotic ecosystems — that is, production systems comprised of communities of plants and animals and their non-living environment. Strictly speaking, a natural area should be restricted to natural ecosystems which are not used by man. A prescribed acreage of such areas is essential so that a supply of plant and animal genes will be available. In this way, non-use is one of the multiple uses. However, the term "multiple-use natural area" implies that on a large proportion of the area there will be a modified natural environment controlled by ecological management. Thus a multiple-use natural area is a pattern of biotic ecosystems which range from truly natural systems, unmodified by man (as far as possible), to those which are slightly modified to provide man with a variety of sensory experiences in a "natural" environment.

Thus, natural areas as a whole are not non-use areas but ones which are managed to serve a pattern of specific purposes, one of which is non-use. The pattern of uses varies from one natural area to another but all those discussed in this report have the potential for two or more of the following uses:
1) forest, marsh and other wildland vegetation for soil and water conservation;
2) natural environment experience — seeing, hearing, smelling, learning;
3) ecological reserves of natural fauna and flora to maintain a permanent gene bank to supply material for other parts of natural areas;
4) extensive recreation;
5) timber production;
6) wildlife production;
7) waterfowl production;
8) fish production.

Each of these uses is dependent upon the production of some type of vegetation, be it forest, prairie, marsh, stream, lake, or combinations of two or more of these types. In this appraisal of land for forest use, the role of tree cover has been the main consideration. The marshland habitat is discussed in greater detail in Chapter 9, Wildlife Resources, but is included in a general way here so that integration of all natural-area uses may be considered. Areas of wild grassland or, more accurately, natural parkland are included here because, though small, they are natural ecosystems of distinct importance as they are part of the natural succession in which forests finally dominate.

The range of the eight uses listed above is so diverse and in some cases so conflicting that it would seem inadvisable to consider them under one management. For instance, it is difficult to reconcile the preservation of a timber species such as black walnut in ecological reserves with the production of timber for furniture stock and hardwood veneer.

The proposal to place all natural areas under one management (hopefully a regional government with full decision making and implementation powers) is made to ensure that weight would be given to each use according to its importance within both a local and a larger context.

The most strategic use is that of the ecological reserve. If these areas are not fully protected there will be no source of the gene supply so necessary to maintain the natural landscape of surrounding areas and to provide materials for many uses, not all of which are now known.

Land for Ecological Reserves

The goal in establishing ecological reserves is to preserve a permanent pool of the genes of the total flora and fauna of the region. To do this a range of physiographic environments must be acquired in which a great variety of natural biotic communities can develop their full range of vegetation successions with a minimum of human disturbance.

As the least disturbed portion of natural areas, ecological reserves, ideally, should be zoned as follows:
1) *A central core* in which the natural communities should not be disturbed by manager, scientist or public;
2) *A middle zone* in which there is a minimum of disturbance by either manager or scientist and no disturbance by the public;
3) *An outer zone* which is a transition between the ecological reserve proper and the areas used by the public as outdoor museums and low-density natural parks.

There are two reasons for including ecological reserves within multiple-use natural areas:
1) *to facilitate* the natural migration of genes from the central protected core to peripheral areas of controlled public access;
2) *to provide* the protection required without undue publicity of the location of unique phenomena such as rare species in danger of extinction.

To avoid the desecration which would likely result, the exact locations of ecological reserves should not be shown on the publicized land-use maps. These should be included in a "back-office" plan showing all of the various uses within each natural area which have been documented by the specialists involved.

Vegetation in Ecological Reserves

The two main classes of vegetation and fauna which are considered in establishing ecological reserves are regional representatives of natural communities, and unique species.

The Ontario Committee of the International Biological Program has recently studied the present and potential areas for nature reserves in the Study Area.[3]

Regional Representatives of Natural Communities. Because of the distribution of vegetation as a continuum over the earth's surface and the mutually dependent inter-actions between vege-

tation and its non-living environment, regional representation must be defined in terms of the relationships of vegetation to specific comparative landform conditions within specific comparative climates. The degree to which species are adapted to a range of landform and soil conditions varies from species to species and from one climatic region to another.

Therefore, for convenience in evaluating patterns of biological production, Ontario has been divided into 13 site regions[4] in which the relationship between succession of vegetation communities and soil features are consistent for each landform position.

For example, the Haldimand-Norfolk Study Area is in the "banana belt" region lying along the north shore of Lake Erie and called Site Region 7E. In this region, vegetation known as the southern mesophytic (or Carolinian) forest occupies only the permeable soils (mostly sands) or landform positions which amplify, rather than attenuate, the effect of the regional climate. *This is the landform pattern which must be acquired if all the components of the southern mesophytic forest under natural conditions are to be reserved.*

Within each region the distribution of individual species may be described by the following classes:

1) *General.* Found on most landform positions in Site Region 7E and therefore of common occurrence almost everywhere. Example, red maple (and formerly American elm).

2) *Specific.* Found on a relatively narrow range of landform positions in Site Region 7E. These species are common in areas where their landform niches occur. Example, tulip tree on hotter than normal landforms.

3) *Restricted.* Restricted to a particular within specific landform niches. May be abundant under such circumstances. stage in the development of vegetation Example, dwarf chestnut, oak and flowering dogwood.

4) *Rare.* Very limited and unpredictable distribution within Site Region 7E, but may be common in some other climatic region. Example, black spruce.

It is the representative species which give character to landscapes and require protection, for without this protection they will become unique.

Unique Species. This is not a class but a pattern of classes. It includes *species at the limit of their range;* for example, black spruce at its southern limit and papaw at its northern limit. It includes *threatened species* such as whorled pigonia *(Isotria verticellata)* and the small white lady's slipper *(Cypripedium candidum)* which are being wiped out in Region 7E although they may be common in other regions. It also includes *relict species,* the presence of one of the few stands on the continent. There are very few relict species in Ontario.

Land for Natural Environment Experience

This category of natural area use includes all the more passive recreational uses. Much has been said about the viewing experience and the importance of landscape esthetics. However, important as this is, man is seeking not only what appeals to his sense of sight but a total natural environment experience. On this theme, Philip Lewis, Director of the Environmental Awareness Center at the University of Wisconsin, has this reference:

> In the December 22, 1961 issue of *Life* magazine, Joseph Wood Krutch, educator, biographer, and naturalist-philosopher, touched on the meaning of this great search for change and variety in the rural-regional landscape when he wrote that . . . we need some contact with the thing we sprang from. We need Nature at least as a part of the context of our lives. . . . Without Nature, without wilderness even, we are compelled to renounce an important part of our heritage. . . . On some summer vacation or some country weekend we realize that what we are experiencing is more than merely a relief from the pressures of city life; that we have not merely escaped from something but have also entered into something; that we have joined the greatest of all communities, which is not that of men alone but of everything which shares, with man, the great adventure of being alive.[5]

One of the most important criteria for this use is diversity. The greater the diversity of individual homogenous areas within a natural-area unit the greater will be the number of satisfied users. But diversity can be achieved only through adequate management plans and effective regulation.

Land for Conservation of Soil and Water

It is a recognized fact that in those places in Europe and elsewhere where a type of rural land use has developed which is compatible with the total environment, there is no need to designate land for soil conservation *per se.* In Haldimand-Norfolk soil conservation can be achieved through a compatible type of multiple-use natural area. Stream banks and lakeshores, for example, are areas where soil conservation can be achieved this way.

Land for Open Space Recreation

Open space recreation includes all recreational activities such as motoring, walking, snowmobiling, skiing, hunting, fishing, canoeing and collecting by a *dispersed population.* Some of these activities — for example, skiing — are engaged in by aggregated populations also — for example, at winter resorts.

Many people combine these active types of recreation with the passive experiencing of the natural environment. Hence, lands with qualities highly suited to both types have a higher recreation value. Some people go fishing to catch fish and don't care where. Others have a good time fishing in a refreshing environment even though they fail to catch a single fish. Still others want both to catch fish and to do so in a pleasant environment. The broader the range of conditions, the greater the number that will be attracted. Physical activities, therefore, require space with pure air and plenty of room for each individual or small group.

If fishing and hunting are involved, the potential of the land to produce the desired species is also important. (Potential ratings for fish and wildlife production are considered in the chapters on fish and wildlife.)

Land for Timber Production

The common concept of timber production is the operation of a large holding managed mainly for that purpose. In many parts of the Study Area, however, the land has such a high capability for the production of high quality wood

(walnut being the ultimate) that the production of wood (even one tree) in many small scattered areas is an important contribution to the economy of the area.

The demand for high quality wood is so steady that trees may be produced on
1) small areas devoted entirely to wood production;
2) areas devoted mainly to producing other types of goods and/or services on which a selective type of forest management for timber production is integrated within multiple-use forest management.

Some other uses, such as parks for campers, may not be compatible with timber production because the trees are often used as clothesline poles, etc., though some modern sawmills are equipped to detect hardware in the logs.

Although the loam and sand lands located mainly in Norfolk County have a higher potential for wood production than the Haldimand clays, the revenue from wood produced from natural areas on these latter soils may be significant.

The capability and suitability of the land for timber production is discussed later in this chapter.

Land for Wildlife and Waterfowl
Both dry land and wet land is required for wildlife and waterfowl. In many cases, wildlife management should be the main objective of selected blocks, either as separate units or as designated blocks within the natural area complex. Seldom, however, is wildlife or waterfowl habitat the sole use of an area. In some cases, such as lowland forest, scrub and grassland, production of timber could be compatible with wildlife. It is also anticipated that considerable wildlife will live in the farming communities, particularly those areas having a pattern of agricultural land and natural areas.

Land for Fish Production
Land is needed to protect fish producing waters from pollution and to provide access for fishermen. Ideally, all shores of fish producing water bodies should be components of adjoining natural areas.[6]

Recreational and Multiple-Use Park Areas
Two low-density population areas are considered here — namely, the intensive recreational areas (of transient, seasonal and permanent residents); and the proposed multiple-use parkland.

Land for Intensive Outdoor Recreation
These are areas in which outdoor recreational activities such as bathing, swimming, skiing and picknicking are carried on by large aggregations of participants. Although initially the areas supporting these activities may be in a natural or near-natural state, sooner or later the natural features are either destroyed or exist within a "cultural" ecosystem.

There are three main types of intensive outdoor recreation:
1) *water-based recreation* — bathing, swimming, boating, water skiing, fishing, etc.;
2) *hill-based recreation* — skiing, hiking;
3) *park-based recreation* — camping, picknicking, outdoor experience.

Intensive recreational land use is being investigated in detail in Chapter 12, Landscape Quality. It is included in this appraisal of land for forest use for two reasons. First, natural vegetation species play an important role in these semi-natural and cultural ecosystems. And second, many of the present parks in the Study Area, are provincial parks located close to, or within, natural areas (see Map 6-4).

In view of the inevitable pressure for intensive use of public parks in the Study Area, they cannot be planned for use as natural areas. Because these parks are already within natural areas they should have clearly defined boundaries. Two distinctly different management plans are needed, one for each of the two clearly defined areas, reflecting their different objectives. The multiple-use natural area plan must ensure very low density trespass population, while multiple-use park management plan will allow for a population of much greater density, though still generally low compared with urban densities.

The two plans could be made and implemented by a single park agency, but only if their goals and objectives are kept distinctly separate.

The main role of trees on areas of intensive recreation is to provide protection from wind and sun, and for esthetic value. Although many of the plant species are the same as those in natural communities, their interrelationships with the other features of the ecosystem may differ greatly. In the recreational ecosystem there is a human-conditioned plant succession. Species which are capable of withstanding human disturbances are selected either by the manager or through natural competition.

Land for Multiple-Use Parkland
Multiple-use parklands are areas in which forest and other natural vegetative cover is required to maintain a permanent parkland environment over a significant proportion of the total area. The intensity of use will fall between that of the natural areas and that of the intensive-use parks.

The lands having the highest suitability rating because of their physiography and relative location are either small areas scattered throughout a broad belt or are narrow sinuous zones within its boundaries. Since these belts are located where urban sprawl is inevitable, they indicate areas on which further residential and industrial development should not be contemplated until a detailed plan is made to integrate the various future uses of the area.

The most suitable land for multiple-use parklands has gentle to moderate relief. Landforms contributing to this relief should be preserved. Ravines and potholes should not be filled, nor steep ridges planed off to accommodate housing developments. These ravine, pothole and ridge areas should constitute the core of the many park areas which would form one of the multiple uses of these belts. Other uses would be determined during the detailed planning.

Another feature which determines the suitability of land for multiple-use parkland is its strategic location in relation to some physiographic or cultural feature. Areas close to Lake

Erie and the Grand River have much greater attraction than those some distance away. Also, existing urban centers provide a focus for potential multiple-use parkland areas.

To meet the objective of providing suitable natural areas for a variety of uses, the features which determine the development of multiple-use natural areas were selected, organized and analyzed within the following contexts.

Context 1)
That the Study Area is an integral part of a developing southern Ontario megalopolis.

The Haldimand-Norfolk area is part of that plain of deep fertile soil lying south of the Precambrian Shield and known as the Great Lakes and St. Lawrence Lowlands of Southern Ontario.

The spectacular increase in the size of aggregated communities and the widespread development of urban sprawl along all the transportation corridors testify that there is emerging a great southern Ontario megalopolis of urban, urbanizing and rural areas occupying this entire lowland plain. Recently, urban and industrial development has been initiated in the distinctly rural environment of Haldimand and Norfolk Counties.

Context 2)
That a program will be implemented to preserve areas of high suitability for agriculture.

The permanent reservation of strategic agricultural areas in Haldimand-Norfolk will protect food production potential and provide open space amenities.

Food Production. Nowhere else in Canada do the climate and soil of broad areas combine to produce the variety, yield and quality of agricultural crops as those presently produced in the lowlands of southern Ontario. Although the capability of the dominant soil types in the Study Area (*i.e.*, the Haldimand clay and the Plainfield sand soil associations) is not so high as that of some other soils, only limited acreages of the better soils will be available for food production due to encroachment of other uses. Therefore, the clay and sandy soils will be important.

Open Space Amenities. The role which open space plays in urbanizing regions is sufficient reason in itself for designating large areas for non-urban uses. However, the fact that the land can be used to supply foods in a quantity and quality not matched elsewhere doubles the preferential ratings of these proposed agricultural reservations.

The nature of open space amenities is discussed in more detail in Context 3 below.

Context 3)
That there will be a program to implement plans to develop, preserve and maintain multiple-use natural areas.

The objectives of this program will be
a) to preserve and maintain natural landscapes which provide visual and other sensory experiences of outstanding value in education and mental health programs;
b) to provide a supply of fresh water and fresh air (complementary to that provided by the strategic agricultural areas);
c) to provide opportunity for extensive open space recreation (complementary to that provided by intensive outdoor recreational areas such as parks, bathing beaches, ski resorts, etc.);
d) to preserve gene pools of representative and rare species of plants and animals;
e) to preserve representative and unique landform features.

Context 4)
That there will be a planned reservation of a system of open space areas, of adequate size and potential, interspersed throughout the entire southern Ontario megalopolis.

In the New York and Washington regions of the North Atlantic megalopolis, welfare-minded politicians and citizens are now realizing the seriousness of the failure to make adequate provision for open space before it was too late.

The present area of urban centers in southern Ontario is a very small percentage of the total, but there is every indication that, unless steps are taken now to direct development areas, the whole of the Southern Ontario Lowlands will be irrevocably removed

from agricultural and other types of open space production.

Context 5)
That current programs, policies and legislation will be fully utilized and/or up-graded to serve as interim measures to reduce the risk of further loss of quality of present multiple-use sites to urban or transportation uses. Such interim measures are to be effective until such times as the programs referred to in Context 3 are fully and effectively implemented.

All counties either wholly or partly within the Study Area have passed bylaws under The Trees Act[7] which are being effectively administered. These bylaws regulate the cutting of trees or the destruction of them by other means. While allowing the harvest of larger trees for timber and any trees for the owners' domestic use, they effectively require that all land that was in forest cover at the time that the bylaws were passed must remain in forest cover.

Municipal governments (townships, towns and cities) and the provincial government, either individually or collectively, as under conservation authorities, have various policies and programs for acquiring or retaining forest land to be part of the public domain and managed as multiple-use natural areas.

There are currently about 10,000 acres of publicly owned forest land within the Study Area that are managed at various degrees of intensity as multiple-use natural areas. In some of these areas — such as nature reserves, public hunting areas and areas of historic significance — the management is specifically defined by the landowners at the various levels of government.

This acreage of publicly owned land will be greatly increased if the reservations suggested in Map 6-5 are implemented. Specific types of management plans for specific multiple-use areas will be a prime requisite during this development.

In the integrated scheme used in this chapter to classify and evaluate land for forest and other types of biological production, the term "physiography" is used in its original meaning — namely, that of connoting all the non-living features of an area of land. Its two main components are *landform* and *climate,* the solid and gaseous portions of the ecosystem respectively.

Landform refers not only to the surface relief, but also to those materials which give substance to that relief. It includes, too, the soil profile which develops in the parent geologic materials.

As mentioned earlier, the province of Ontario has been subdivided into site regions, in each of which there are similar relationships between the development and growth of vegetation and the landform features which support them, indicating a narrow range in regional climate. The Haldimand-Norfolk Study Area is located in the site region with the most favorable soil and climate in Ontario — Site Region 7E.[8]

The ultimate subdivision of each site region is a small local homogenous area known as the *physiographic site type* — a combination of soil type, relief and local climate. Since site types are homogenous with respect to biological production, they are the basic units for land appraisal. Because of their small size and because the use of one affects the use of those around it, patterns of physiographic site types known as *landscape units* are used in land use planning.

The Haldimand-Norfolk Study Area has been divided into 18 landscape units based on significant landform features. These landform features provide a stable reference base upon which changes in vegetative cover, animal life, and cultural features may be appraised as changes are made in the use and management of land. Thus the landscape unit should be considered a dynamic patterned entity which may develop in several directions as dictated by combinations of 1) the potential of each component of the land pattern, 2) the individuals of the human community, and 3) their land management practices. Each landscape unit is a pattern of biological and cultural features which are determined in part by the physiographic features used to define them. Thus, while landscape units are defined in physiographic terms of relief, climate, soil and water, they are actually areas of production of goods and services. Within the framework of these 18 landscape units of the Study Area, the detail of the appraisal of land for forest use is presented.

The appraisal of the non-urban land in the Haldimand-Norfolk Study Area for the production of forest and other non-farm vegetation and the role of this vegetation in multiple-use natural areas is based on:
1) the *capability* of the land to produce timber crops;
2) the *capability* of the land to provide the basis for multiple-use natural areas;
3) the *suitability* of the land for multiple-use natural areas.

The assessment of land capability is used to *differentiate between various homogenous areas of land for a given use*. Land capability, in itself, is inadequate and, in fact, misleading as a guide to differentiating *between various uses* for a given area of land. There is no relationship established between capability classes for the various uses. The fact that the capability rating of an area is Class 1 for timber production and Class 3 for agriculture does not necessarily mean that the land should be used for wood production.

The degree to which the production potential is being realized for a given area of land is not considered in the determination of a land capability rating. However, the degree to which land is developed, as may be required to achieve its potential capability, is reflected in the rating of land suitability for a given use. Again, as with land capability, the rating of land suitability is a *differentiation between various homogenous areas of land for a given use*. Suitability classes are not designed to establish relationships between various uses of the same area and thus suitability ratings are not a direct guide to differentiating between uses.

The areal unit of land used in this appraisal is the homogenous unit known as the physiographic site type discussed in the previous section. Although the appraisal of the physical features of each homogenous parcel of land has some meaning to the land manager, it is of little use to either the manager or the regional planner until it is placed in a system of ratings which indicate its comparative potential within the region and the province. Such a system was developed in the Research Branch of the Ontario Department of Lands and Forests and is now being applied by the Ontario Land Inventory and other units of that department. Since the Land Inventory group has not completed the details of its work in the Haldimand-Norfolk Study Area, the present appraisal was carried out in the manner described below, using the methods and principles adopted by the Ontario Department of Lands and Forests.

Table 6-1 / Potential Wood Production Net Merchantable Cubic Feet per Acre-Year[1] Site Region 7E

Physiographic Site Type[2]		Stand Type[3]			
Texture	Moisture	Pine	Lowland Hardwood	Upland Hardwood	Mesophytic Hardwood Southern
Clay, clay loam and clay till	Dry	10	0	15	0
	Fresh	60	60	50	10
	Moist	75	75	50	10
	Wet	30	60	10	0
	Saturated	0	0	0	0
Loam, sand-loam, silt-loam, and well-structured clay	Dry	100	50	50	60
	Fresh	150	120	120	120
	Moist	70	170	85	80
	Wet	15	120	15	50
	Saturated	0	0	0	0
Fine sands and silty sands	Dry	100	40	30	30
	Fresh	170	110	120	100
	Moist	120	150	100	150
	Wet	30	100	15	130
	Saturated	0	40	0	0
Coarse and medium sand	Dry	100	30	40	40
	Fresh	170	100	100	80
	Moist	75	130	80	110
	Wet	30	100	40	60
	Saturated	0	40	0	0

[1] (a) Net merchantable volume for pine includes all material with a top diameter of 3.5 inches and over (measured inside bark).

(b) Net merchantable volume for hardwood includes all material with a top diameter of 6.5 inches and over (measured inside bark). It includes material from a fork, but does not include normal branches.

[2] See page 87
[3] See page 89

Capability of Land to Produce Timber Crops

Land capability classification is a rating of an area for the *potential* production of a specific crop or group of crops which can be realized using a specified level of technology. The most progressive level of land management technology practices in a given region is the usual benchmark.

These use capability ratings have been determined for each discrete area recognized within the Study Area (see the following section). Such areas may be homogenous from the standpoint of physiography or they may be homogenous because of a certain intimate pattern of physiographic variation. They may, for example, be homogenous by virtue of specific patterns of heterogeneity. The regional climatic controls on biological production are considered to be constant throughout the Study Area.

The benchmarks used to assess and rank the land capability for timber production are forest stands that have the highest demonstrated output for those stand types on their respective site types within the Study Area.

Table 6-1 shows the outputs of the various site types used as benchmarks in the assessment of land capability for timber production. The inputs are zero in each case since these are stands

which have developed under natural conditions.

To compile the potential wood production data presented in Table 6-1, the available reliable mensurational data were reviewed. Because only limited data were available, field measurements were made of suitable stands in some of the few remaining highly productive woodlots within the Study Area. To get the full range of ratings shown in this table the authors drew heavily on data gleaned from many years of experience in the Study Area.

The data in the table provide the basis for potential production classes which indicate the capability of the land to produce a specific species or group of species within specific plant communities. From potential production classes, a general capability rating for timber production is established. The following scale of seven classes of the general rating refers to Site Region 7E:

Class 1
Excellent land for wood production (the best in the site region.)

Class 2
Very good.

Class 3
Good.

Class 4
Moderately good.

Class 5
Poor.

Class 6
Very poor.

Class 7
Extremely poor forest land (the poorest in the site region for timber production but of value as protection forest, landscape esthetics, etc.).

Within Site Region 7E and within the Study Area itself, there are lands with a higher potential for timber production than any other land in the province.

Forest Stand Types

Since different combinations of landform and soil conditions produce differences in the adaptation of the various species, forest stand types are established for convenience in showing relationships between forest production and combinations of soil and climate. The following stand types were used in this chapter.

1) Pine

White and red pine were the production indicator species used.

2) Lowland Hardwood

Cottonwood and silver maple were the production indicator species used.

3) Upland Hardwood

The production indicator species used were sugar maple, white ash, basswood and red oak. Other important components of some of the stands used were white oak, beech, red maple and black cherry.

4) Southern Mesophytic Hardwood

Production indicator species used were upland hardwood stand types that had components of either tulip tree or black walnut or both.

General capability ratings are based on the potential of the land to produce a number of commercial species. For example, land which produces good hardwood as well as good pine has a higher rating than one which produces only good pine. Also, if one of the few species produced has a very high value, such as walnut, this might logically raise the general rating considerably. However, there are very few landscapes in which the proportion of land with a moderate to high potential for walnut production is sufficiently large to influence a general rating of the landscape. Such areas can be designated only on a more detailed presentation.

Capability of Land to Provide the Basis for Multiple-Use Natural Areas

The assessment of the capability of land for multiple-use natural areas requires that several other factors be considered in addition to those which directly influence timber production. However, there is a very strong correlation between a capability for timber production and a capability for multiple-use natural areas.

Usually, for example, a terrestrial area which can produce abundant and diverse biotic communities, and sustain uses dependent on them, has also a high timber capability. There are, however, a few situations (areas with an intimate pattern of productive and non-productive sites, for example) that have a low capability for timber production but a high capability for the production of diverse biotic communities. Such an area would likely be rated as having a higher capability for multiple-use natural areas than for timber production.

In assessing timber production capability such factors as landform, water bodies, minerals, unique sites, and the pattern or association of any or all of these are not considered. They are, however, important considerations in assessing capability for multiple-use natural areas. Also, the more diverse an area is, the higher is its capability for multiple-use natural area purposes and, usually, the lower is its potential for timber production.

There are areas within and adjacent to the Study Area that have a great diversity of features important to the potential of a multiple-use natural area. These areas were chosen as standards against which to assess and rank the capability of other areas for multiple-use natural areas. One of the factors considered was potential for extensive outdoor recreation (the intensively developed camping areas and swimming beaches of provincial parks, for example was considered to be outside of the role of a multiple-use natural area). However, areas that have a high capability rating for multiple-use natural areas would likely have a similarly highly capability rating for intensive recreational areas. The converse would not necessarily be true.

The Suitability of Land for Multiple-Use Natural Areas

Land capability ratings indicate the potential for a particular use of a given piece of land. Land suitability ratings indicate how much investment (time, money, effort) is required for the land to realize its potential for that use.

Within the Study Area, the suitability of areas for multiple-use natural areas was determined from the land

capability and from the present distribution of natural vegetation.

The relatively high level of importance given to established natural cover reflects the high inputs (especially the long periods of time) required to establish forests and other natural vegetation on non-forested land and the valuable role played by forest cover (or patterns of it) in multiple-use natural areas. It also indicates the value of the existing forest cover and the efforts that could be justified to maintain it.

Areas that now support various types of unique flora or fauna have also been considered to have a high suitability for multiple-use natural areas. Unique flora such as rare species, big trees, and species of geographical interest are usually irreplaceable. Likewise, most geological formations, once destroyed, will not be re-formed by nature; they are gone forever.

The suitability ratings of land for multiple-use natural areas are relative only within the Study Area and probably areas adjacent to it. The suitability of land for multiple-use natural areas is presented within the context of the assumed other major land uses within the Study Area.

Description of the Natural Landscape Units of The Study Area

Designation of Units and Sub-Unit Classes

Physiographically defined land units constitute the most stable frame of reference for planning the development of the natural resources of a region.[9] For convenience in describing the land productivity systems of the Study Area, it was divided into 18 well-defined land patterns (natural landscape units) described below. These landscape units have been assigned both names and numbers (1 to 18). The location of the 18 landscape units appears on Maps 6-1 to 6-4.

Features Described in Text and Maps

Each landscape unit is described under five main headings.
A. Distinctive Physiographic Character.
B. Present Natural Vegetative Cover and Land Use.
C. Land-Use Capability Ratings (also Maps 6-1 and 6-2).
D. Land-Use Suitability Ratings for Multiple-Use Natural Areas (also Map 6-3).
E. Future Role of Forest and Other Natural Vegetation (shown on Map 6-4 by numbered sub-units).

Assumptions Made

It is necessary that certain assumptions be made concerning the dominant future use of each landscape unit before the role of the natural vegetation can be assessed. *Exceptions to this are those multiple-use natural areas which are strategic and which must be reserved for this use at all costs.* See Map 6-5 and page 97 for a summary of those strategic aspects of the total landscape which must be protected.

Inventory of Landscape Units

1. Canfield Landscape Unit

A. Distinctive Physiographic Character
Landform: Potholed, gently undulating, clay plain.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Red and silver maple, white and burr oak, hickory, largetoothed aspen and basswood.
Forested Tracts: Mainly where potholes are concentrated.
Farm Woodlots: Generally high graded and heavily pastured.

C. Land Capability Rating
Timber
Over 90% of unit: Fourth rate for upland and lowland hardwood.
Multiple-Use Natural Areas
80% of unit: Fifth rate.
20% of unit: Third rate — stream courses and blocks of forest.

D. Land Suitability Rating for Multiple-Use Natural Areas
Moderate: Present forest blocks and stream courses.
Low: Remainder of unit.

E. Future Role of Forests and Other Natural Vegetation
Assumption: Dominant use of unit will be intensive agriculture.
Sub-unit Classes
1) Stream courses: Multiple-use natural areas on bottomlands, banks and other lands susceptible to or affected by erosion.
2) Areas with concentration of potholes: Multiple-use natural areas. Public ownership of blocks containing 500 acres or more is suggested.
3) Remainder of undulating till plain: Dominant use — intensive agriculture. Maintain woodlots only on lands which are highly suitable for multiple-use natural areas.

2. Dunnville Landscape Unit

A. Distinctive Physiographic Character
Landform: Level plains of clay and potholed sand and silt flanking the Grand River mouth; poorly to imperfectly drained.
Crop Climate: Warmer than normal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Red and silver maple, white, red and burr oak, hickory, green ash and basswood.
Forested Tracts: Concentrated on poorly drained sands of southeast

Moulton Township.
Farm Woodlots: A pattern of well-distributed farm woodlots, many in poor condition, high graded and pastured.
Marsh Vegetation: On banks and islands of Grand River; being changed by industry.

C. Land Capability Rating
Timber
70% of unit: Second rate for both upland and lowland hardwood.
20% of unit: Fourth rate for lowland hardwood.
10% of unit: Third rate for upland hardwood.
Multiple-Use Natural Areas
50% of unit: Second rate.
30% of unit: First rate — Lakeshore and Grand River banks.
20% of unit: Fourth rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
High: River banks, marshes and portions of lakeshore.
Moderate: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Sub-unit Classes
a) Banks and bottomlands of the Grand River and tributaries:
i) multiple-use forested natural areas;
ii) multiple-use marsh natural areas;
iii) public recreational park.
b) Lake Erie shoreland:
i) residential park type of multiple-use natural areas in strategic locations;
ii) present intensive recreational parks.
c) Remainder of unit — intensive agriculture dominant use:
i) farm woodlots (not shown on maps).
ii) system of shelter belts (not shown on maps).

3. Cayuga Landscape Unit
A. Distinctive Physiographic Character
Landform: Hills and vales of shaley loam and clay with relief mainly from stream erosion, supplemented by irregular distribution of drumlins.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetation and Forest Land Use
Principal Timber Species: Red oak, hard maple, beech, basswood, hemlock, with some white oak.
Forested Tracts: None over 200 acres.
Farm Woodlots: On almost every farm; small but in good state of production.

C. Land Capability Rating
Timber
70% of unit: Second rate for upland hardwood.
20% of unit: Fourth rate for upland and lowland hardwood.
10% of unit: First rate for upland hardwood.
Multiple-Use Natural Areas
60% of unit: Second rate.
30% of unit: First rate.
10% of unit: Third rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
Moderate: Most of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Dominant land use will be a combination of agriculture and residential parks until the farmer is finally phased out.
Sub-unit Classes
1) Banks and bottomlands of the Grand River and its tributaries with any adjoining areas needed for the protection of the valley landscape: Multiple-use natural areas.
2) Remainder of unit: Uplands of hills and vales.
a) Residential parks (landscaped subdivisions and wooded parks);
b) Most suitable areas for continuing agriculture and farm woodlots.

4. Hagersville Landscape Unit
A. Distinctive Physiographic Character
Landform: Clay-capped limestone plain. Cuesta and dip slope of the Onondaga Escarpment almost hidden by the Haldimand clay till.

Crop Climate: Modal for Site Region 7E.
B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Hickory, red and silver maple, green and white ash, white and red oak and basswood.
Forested Tracts: None; no large swamps.
Farm Woodlots: On two-thirds of farms; heavily pastured and unproductive.

C. Land Capability Rating
Timber
70% of unit: Fourth rate for upland hardwood.
20% of unit: Fifth rate for upland and lowland hardwood.
10% of unit: Sixth rate for upland hardwood (red cedar).
Multiple-Use Natural Areas
50% of unit: Fourth rate.
50% of unit: Fifth rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
Low: Most of unit.

E. Future Role of Forest and other Natural Vegetation
Assumption
i) This area will be reserved for mining of aggregates which can be done with less desecration of the landscape than on the Niagara Escarpment.
ii) Management of the area after quarrying will be as multiple-use natural areas.
Sub-unit Classes
1) Pits, mounds, and artificial lake areas: multiple-use natural areas with red cedar and Canada blue grass playing an important role in early stages of establishment on the raw soil materials.
2) Areas of the undulating clay plain not yet in the sphere of the quarries.
a) Shallow soil; permanent pastures supplemental to farm economy.
b) Other areas: agriculture with farm woodlots.

5. Selkirk Landscape Unit
A. Distinctive Physiographic Character
Landform: Stream and rivulet channelled clay plain with rivulets originating in narrow muck-filled channels rather than broad swamp areas.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Hickory, green ash, basswood, white and red oak.

Forested Tracts: None; no large wetland areas.
Farm Woodlots: Small and in poor condition. Least percentage of forest cover of any unit, no forests along stream courses.

C. Land Capability Rating
Timber
90% of unit: Fourth rate for upland forest.
10% of unit: Second rate for upland and lowland hardwoods.
Multiple-Use Natural Areas
60% of unit: Fifth rate.
30% of unit: Second rate.
10% of unit: Fourth rate.

D. Land Suitability for Multiple-Use Natural Areas
Moderate: Along stream courses and portions of lakeshore.
Low: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Haldimand Clay has been downrated unjustly because small farmers are unable to use it to its full potential. Considering the relative potential among available farmland within the province, this unit has a moderately high suitability. Therefore it is assumed that the future dominant use will be intensive agriculture.
Sub-unit Classes
1) Stream courses: multiple-use natural areas along streams and on adjacent lands.
2) Lake Erie shoreland:
a) Residential parks with landscaped subdivisions and woodland parks. Multiple-use natural areas in strategic locations.
b) Existing intensive recreation parks.
3) Remainder of unit: intensive agriculture. Land capability for timber so low and woodlots in such poor condition that they have a low suitability for timber production.

6. Nanticoke Landscape Unit

A. Distinctive Physiographic Character
Landform: Potholed and rivulet-channelled clay plain. It was separated from the Selkirk Unit because of its better structure and the greater lime content in the soil, and the occurrence of potholes (or sloughs) in some parts.
Crop Climate: Warmer than normal for Site Region 7E.

B. Present Natural Vegetation and Forest Land Use
Principal Forest Species: Hickory, white and red oak, basswood and green ash.
Farm Woodlots: Less pastured and in better condition than in the Selkirk Unit.

C. Land Capability Rating
Timber
60% of unit: Fourth rate for upland hardwood.
40% of unit: Second rate for upland and lowland hardwoods.
Multiple-Use Natural Areas
Nearly all of unit: Fourth rate.

D. Land Suitability for Multiple-Use Natural Areas
Moderate: Along stream courses and portions of lakeshore.
Low: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Intensive industrial use in area near Ontario Hydro Development along Lake Erie. Providing no air pollution, intensive agriculture over remainder of area.
Sub-unit Classes
1) Stream courses: multiple-use natural areas along streams and on adjacent lands.
2) Lake Erie shoreland:
a) residential parks.
3) Remainder of unit: intensive agriculture. Maintain present farm woodlots.

7. Simcoe Landscape Unit

A. Distinctive Physiographic Character
Landform: Morainic and deltaic sand plain.
Crop Climate: Warmer than normal crop climate, a combination which places the unit in a unique position for the production of the so-called Carolinian flora.

B. Present Natural Vegetation and Forest Land Use
Principal Timber Species: Red oak, white ash, basswood, hard maple, beech, white oak, red and silver maple.
Outstanding Carolinian Flora: Tulip tree, magnolia, flowering dogwood, sassafras, dwarf chestnut oak, and many others.
Farm Woodlots: Well stocked and very little pasturing.
Stream Courses: Most are wooded.

C. Land Capability Rating
Timber
70% of unit: Second rate for upland and southern mesophytic hardwood.
30% of unit: First rate; species as above
Multiple-Use Natural Areas
Nearly all of unit: First rate.

D. Land Suitability for Multiple-Use Natural Areas
High: Along stream courses and portion of lakeshore.
Moderate: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Owing to proximity of the Ontario Hydro and Stelco development immediately to the east of the landscape unit there will be considerable urban development near Port Dover and Simcoe.
Sub-unit Classes
1) Stream courses: multiple-use natural areas along streams and on adjacent lands.
2) Lake Erie shoreline
a) Residential park with landscaped subdivisions and wooded parks.
b) Intensive recreation parks (not yet selected).
3) Remainder of unit: a smooth sand plain — agriculture, Retain farm woodlots.

8. Walsingham Landscape Unit

A. Distinctive Physiographic Character
Landform: Wet flats and dry ridges of deltaic sand.
Crop Climate: Hotter than normal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Red, silver and hard maple, red and white oak,

/hite ash and beech, with some white
ine, swamp white oak, and hemlock.
Inique Carolinian Flora: Black gum,
ulip, magnolia, sassafras, flowering
ogwood and many others.
orest Tracts: Large acreage of conifer-
us plantations on dry sand. Large tracts
f lowland forests. These have been
eavily cut and only in a few cases has
egeneration been satisfactory.
arm Woodlots: A few hardwood wood-
ts on upland sand in good condition
ith little pasturing.

. Land Capability Rating
imber
0% of unit: Second rate for pine,
outhern mesophytic and lowland
ardwood.
0% of unit: First rate for southern
esophytic and upland hardwood.
0% of unit: Third rate for pine, southern
esophytic and lowland hardwood.
'ultiple-Use Natural Areas
0% of unit: Second rate for ecological
serves and timber.
0% of unit: First rate for ecological
serves and timber.
0% of unit: Third rate for timber.

. Land Suitability for Multiple-Use
atural Areas
igh: Stream courses, greenbelts.
oderate: Remainder of unit.

Future Role of Forest and Other
atural Vegetation
ssumption: This unit will remain an
en space area of intensive agriculture
ith timber production in plantations,
rm woodlots and multiple-use forest
acts.
ub-unit Classes
Stream courses: multiple-use
tural areas along streams and on
ljacent lands.
Multiple-use natural areas (including
ological reserves).
Rest of unit: agricultural. Maintain
odlots on lands which have a high
itability for multiple-use natural
eas.

Port Rowan Landscape Unit

Distinctive Physiographic Character
ndform: Sand dunes, marshes and clay shorelands; includes Turkey Point and Long Point.
Crop Climate: Warmer than normal for Site Region 7E.

B. Present Natural Vegetation and Forest Land Use
Principal Timber Species: On clay shoreline, similar to Delhi Landscape Unit.
Unique Flora: On sand spits and marshes — black spruce, poison sumac, and others.

C. Land Capability Rating
Timber
50% of unit: Second rate for upland and southern mesophytic hardwood.
30% of unit: Sixth rate for pine and upland hardwood.
20% of unit: Seventh rate for pine and intolerant hardwood.
Multiple-Use Natural Area
50% of unit: First rate.
50% of unit: Second rate.

D. Suitability Rating for Multiple-Use Natural Areas
High: Marsh, stream courses, sand points and forest blocks.
Moderate: Remainder of unit.

E. Future Role of Forests and Other Natural Vegetation
Assumption: The dominant uses will be
i) regulated management of intensive recreation areas, public hunting areas and ecological reserves on the beaches, dunes and marshes;
ii) residential, commercial and intensive recreational areas on the remainder.
Sub-unit Classes
1) Beaches, dunes and marshes
a) Existing intensive recreational parks.
b) Multiple-use marsh natural areas (including ecological reserves).
c) Residential parks.
2) Backland and lakeshore clay areas
a) Recreational park. Multiple-use natural areas on strategic locations.
b) Multiple-use natural areas (including ecological reserve).
c) Residential park.
d) Stream courses: multiple-use natural areas.

10. Villa Nova Landscape Unit

A. Distinctive Physiographic Character
Landform: Limy clay flats.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Red, silver and hard maple, hickory, white ash, basswood, beech and red oak.
Forest Tracts: None over 100 acres.
Farm Woodlots: Well distributed, some in good condition but some are heavily pastured.

C. Land Capability Rating
Timber
70% of unit: Third rate for upland and lowland hardwood.
30% of unit: Second rate for upland and lowland hardwood.
Multiple-Use Natural Areas
Nearly all of unit: Third rate.

D. Land Suitability for Multiple-Use Natural Areas
Moderate: Along stream courses.
Low: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Intensive type of agriculture will develop.
Sub-unit Classes
1) Stream courses: multiple-use natural areas along streams and on adjacent lands.
2) Agricultural clay flat: maintain woodlots on those lands which have a high suitability for multiple-use natural areas. Establish wind breaks on suitable locations.

11. Waterford Landscape Unit

A. Distinctive Physiographic Character
Landform: Ridges and swamps of deltaic and morainic sand and gravel.
Crop Climate: Warmer than normal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Red and white oak, hard maple, beech, white pine, basswood, white ash, red and silver maple, cedar and aspen.

Forest Tracts: Several large areas of swamp forest adjacent to moraine.
Farm Woodlots: Not generally pastured.

C. Land Capability Rating
Timber
60% of unit: Second rate for upland and lowland hardwood.
20% of unit: First rate for upland hardwood.
20% of unit: Fifth rate for upland and lowland hardwood.
Multiple-Use Natural Areas
80% of unit: Second rate.
20% of unit: First rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
High: Stream courses and greenbelts.
Moderate: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Unit remains an open space area having a pattern of farm and forest land.
Sub-unit Classes
1) Stream courses: multiple-use natural areas along streams and on adjacent lands.
2) Multiple-use natural areas (including ecological reserves).
3) Agricultural areas: maintain woodlots on those lands which have a high suitability for multiple-use natural areas.

12. Delhi Landscape Unit

A. Distinctive Physiographic Character
Landform: Deltaic and morainic plain of sand and gravel deeply entrenched by Big Creek.
Crop Climate: Hotter than normal for Site Region 7E.

B. Present Natural Vegetative Cover and Present Use of Forest Land
Principal Timber Species: Red and white oak, hard, red and silver maple, beech, basswood, white ash, and white pine.
Unique Carolinian Flora: Occasional sycamore.
Forest Tracts: None over 100 acres.
Stream Courses: Both sides of Big Creek are forested for 90% of its length (in the unit) and for a width of at least 130 feet.
Farm Woodlots: Well distributed and in good condition; little pasturing (tobacco rather than livestock farm economy generally).

C. Land Capability Rating
Timber
60% of unit: Second rate for upland and lowland hardwood.
40% of unit: First rate for upland and southern mesophytic hardwood.
Multiple-Use Natural Areas
70% of unit: Second rate.
30% of unit: First rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
High: Stream valleys.
Moderate: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Intensive agriculture will be dominant use.
Sub-unit Classes
1) Stream courses: multiple-use natural areas (including ecological reserves) along streams and on adjacent lands.
2) Remainder of Unit: agricultural sand plain. Maintain woodlots on those lands which have a high suitability for multiple-use natural areas.

13. Tillsonburg Landscape Unit

A. Distinctive Physiographic Character
Landform: Sand-capped moraine deeply entrenched by Otter Creek and its tributaries.
Crop Climate: Warmer than normal for Site Region 7E.

B. Present Natural Vegetation and Forest Land Use
Principal Timber Species: Hemlock, otherwise similar to Delhi.
Unique Carolinian Flora: Sparse, occasional sycamore.
Farm Woodlots: A few in areas of intensive agriculture; little pasturing.

C. Land Capability Rating
Timber
50% of unit: Second rate for upland and lowland hardwood.
30% of unit: Third rate for upland hardwood.
20% of unit: First rate for upland and southern mesophytic hardwood.
Multiple-Use Natural Areas
50% of unit: First rate.
50% of unit: Second rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
High: Stream valleys.
Moderate: Rest of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Considerable urbanization in vicinity of Tillsonburg. Increased use of natural covers in the valleys and associated areas. Intensive agriculture on the remainder of the unit.
Sub-unit Classes
1) Stream courses: Multiple-use natural areas along streams and on adjacent lands including potential woodland parks and ecological reserves.
2) Residential park.
3) Smooth agricultural plain. Maintain woodlots on those lands which have a high suitability for multiple-use natural areas.

14. Port Burwell Landscape Unit

A. Distinctive Physiographic Character
Landform: Sand-capped silt and clay till bordering Lake Erie.
Crop Climate: Warmer than normal for Site Region 7E.

B. Present Natural Vegetation and Forest Land Use
Principal Timber Species: Hard maple, beech, hemlock, white ash, red oak, basswood, red and silver maple, black cherry and some white pine.
Unique Carolinian Flora: Papaw and fe other species in vulnerable locations.
Farm Woodlots: Not generally pasture
Stream Courses: Not wooded.

C. Land Capability Rating
Timber
Over 90% of unit: Second rate for upland and southern mesophytic hardwood.
Multiple-Use Natural Areas
Over 90% of unit: Second rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
High: Stream valleys portions of lakeshore.
Moderate: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Assumption: Possible urban development.
Sub-unit Classes
1) Stream courses: multiple-use natural areas — along streams and enlarged to include ecological reserves of unique vegetation in adjacent areas.
2) Residential park (may include industrial and commercial areas). Multiple-use natural areas in strategic locations.
3) Present intensive recreational park.

15. Norwich Landscape Unit

A. Distinctive Physiographic Character
Landform: Sag and swell till plain.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetation and Forest Land Use
Principal Timber Species: Hard, red and silver maple, white oak, beech, basswood and white ash.
Forest Tracts: No large areas.
Farm Woodlots: Well distributed throughout unit; generally pastured (dairy farm economy).

C. Land Capability Rating
Timber
70% of unit: Third rate for upland hardwood.
30% of unit: Second rate upland and lowland hardwood.
Multiple-Use Natural Areas
Nearly all of unit: Fourth rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
Moderate: Stream courses and present greenbelts.
Low: Remainder of unit.

E. Future Role of Forest and Other Natural Vegetation
Sub-unit Classes
1) Stream Courses: multiple-use natural areas along streams and on adjacent lands.
2) Multiple-use natural areas on wetlands.
3) Rest of unit: agricultural land. Although the potential for timber production is relatively high, many of the present woodlots are as well suited for agricultural development as for improved woodlots.

16. Paris Landscape Unit

A. Distinctive Physiographic Character
Landform: Maze of morainic loam hills and spillway gravel terraces.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetation and Land Use
Principal Timber Species: Wetlands — red and silver maple, cedar; *Gravel Terraces*— hard maple, red oak, white ash, beech and basswood.
Forest Tracts: Most of forests in unit are poorly drained depressions generally 200-300 acres in size.
Farm Woodlots: Small and in poor condition generally.

C. Land Capability Rating
Timber
60% of unit: Second rate for lowland and upland hardwood.
30% of unit: Third rate for upland hardwood.
10% of unit: Fifth rate for lowland hardwood.
Multiple-Use Natural Area
80% of unit: Second rate.
20% of unit: First rate.

D. Land Suitability for Multiple-Use Natural Areas
High: Banks of Grand River and tributaries; large swamps.
Moderate: Remainder of unit:

E. Future Role of Forest and Other Natural Vegetation
Assumption: Many tracts will be required to supply aggregates. Urbanization will follow rather than precede mining.
Sub-unit Classes
1) Public multiple-use natural areas on wetland.
2) Till area for agricultural use. Maintain woodlots on those lands which have a high suitability for multiple-use natural areas.
3) Remainder of area:
(a) Residential park.
(b) Landscape subdivisions and woodland parks on reclaimed land after gravel quarrying.

17. Tuscarora Landscape Unit

A. Distinctive Physiographic Character
Landform: Undulating plain of stonefree silt often with shallow sand capping; also areas of clay till.
Crop Climate: Modal for Site Region 7E.

B. Natural Vegetative Cover and Forest Land Use
Principal Timber Species: White and red oak, hickory, red, silver and hard maple, white ash, basswood and beech.
Six Nations and Other Indian Reserves: There are many large tracts of forests in the middle of the concessions of these reserves. Many of these tracts have been continuously high graded and intermittently pastured.

C. Land Capability Rating
Timber
70% of unit: Fourth rate for upland and lowland hardwood.
30% of unit: Second rate for upland hardwood.
Multiple-Use Natural Areas
60% of unit: Second rate.
40% of unit: Third rate.

D. Land Suitability Rating for Multiple-Use Natural Areas
Moderate: Most of unit.

E. Future Role of Forests and Other Natural Vegetation
Assumption: Much of the land in the Indian Reserves will be managed on a multiple-use basis similar to that of the multiple use of other forest lands except that there will be larger areas of cleared land.
Sub-unit Classes
1) Stream courses: multiple-use natural areas along streams and on adjacent lands.
2) Indian Reserve
(a) Indian Reserve Forest. Many of these forests are located on lands having high suitability for intensive agriculture.

However, under the type of multiple-use management now being practised, these forests will continue to play an important role in that economy.
(b) Indian Reserve farmland.
3) Areas of land not within the Indian Reserves: intensive agriculture with farm woodlots on those areas of a low suitability for intensive agriculture.

18. Onondaga Landscape Unit

A. Distinctive Physiographic Character
Landform: Undulating silt plain entrenched by the Grand River and its tributaries.
Crop Climate: Modal for Site Region 7E.

B. Present Natural Vegetative Cover and Forest Land Use
Principal Timber Species: Hard maple, white ash, red and white oak, basswood, red and silver maple and beech.
Stream Courses: Little protection by forests.
Forested Tracts: Mostly 100 acres or less.
Farm Woodlots: A few scattered woodlots, not many pastured but high grading general.
C. Land Capability Rating
Timber
70% of unit: Fourth rate for upland and lowland hardwood.
30% of unit: Second rate for upland hardwood.

D. Land Suitability Rating for Multiple-Use Natural Areas
High: Grand River and tributaries.
Moderate: Remainder of unit.

E. Future Role of Forest and Other Vegetation
Assumption: The city of Brantford will eventually expand eastward on the moderately undulating areas.
Sub-unit Classes
1) Stream courses: Multiple-use natural areas along streams and on adjacent lands.
2) Residential park.
3) Remainder of area: in agriculture. Maintain woodlots on lands which are highly suitable for multiple-use natural areas.
4) Indian Reserve: agricultural land.

General Location of Potential Ecological Reserves of Strategic Importance
Reference has already been made to the survey of potential ecological reserves in Ontario by the Ontario Subcommittee for the International Biological Program (IBP) of the International Union of Biological Sciences. The objective of the IBP survey and the description of the areas investigated in the Study Area have been summarized in an unpublished paper entitled "Strategic Ecological Reserves in the Haldimand-Norfolk Region" by G. A. Hills and S. Walshe. The locations of these areas have been added to Map 6-4 and are numbered 61 to 80 inclusive.
These numbers were chosen arbitrarily to avoid confliction with other area numbers in the maps.
The following is a list of the numbers and descriptive names assigned to these areas.
61 — Long Point Dunelands
62 — Long Point Marshlands
63 — Turkey Point Dunelands and Marshlands
64 — Turkey Point Peatlands
65 — Springvale Peatlands
66 — Turkey Point Parklands
67 — St. William's Parkland
68 — Backus Sandlands
69 — West Walsingham Sandlands
70 — Walsh Sandlands
71 — Charlotteville Sandlands
72 — Spooky Hollow Loamlands
73 — Kelvin Loamlands
74 — York Loamlands
75 — Black Creek Valleylands
76 — Canborough Wetlands
77 — Burford Mucklands
78 — Oakland Mucklands
79 — Vienna Valleylands
80 — Bayham Loamlands

The scenario presented here is based on the *suitability* of the land for forests and other natural vegetation. It is a model constructed to focus attention on strategic areas that should constitute decision points in the overall development plan for the Haldimand-Norfolk Study Area. This is done by showing a generalized integrated pattern of the *relative* suitability of the present ecosystems (productivity systems) for providing the natural environment which will be needed[11] by the year 2000. This environment may be achieved either through reserving areas of natural landscapes or by preserving natural elements in a cultural one.

The generalization of the detailed investigations of the capability and the suitability of patterns of local homogenous land areas has been undertaken at this stage to indicate the type of value judgments which will be needed to integrate this forest land-use appraisal into the total development plan. These value judgments have been made by the authors, who are familiar with the dynamic relationships between the natural vegetation and its physiographic controls, both present and past. Based on this knowledge the following is proposed for the future in the context of present and anticipated pressures.

Kahn and Weiner have referred to a scenario as a "hypothetical sequence of events". This does not apply here. This scenario expresses a series of integrated goals for preserving the natural environment, the fulfilment of which depends on timing as an *urgency* rather than a *sequence*. For example, many of the strategic natural-use areas shown on Map 6-5 really exist on the ground today, but will *not be found anywhere in the year 2000 unless action is taken to reserve them now*. Such action must also apply to additional areas to complement those now existing. So critical is the need for action that most of the steps necessary should be taken within the next year or two. These may be construed as a sequence of events but, contrary to Kahn and Weiner, they are by no means "hypothetical" unless of course, they are not incorporated in a comprehensive plan for implementation. In any case, they do

express real needs.

The name "scenario" for the model has been retained in spite of the above discussion because it expresses an idealized picture of the role which natural landscape and natural vegetation must play if present and future populations of this Study Area are to enjoy the heritage which is theirs.

Strategic Areas

Webster's Dictionary defines "strategic" as "of great importance within an integrated whole or to a planned effect". The scenario (Map 6-5) shows the subdivision of the region into seven types of areas, five of which are important from the standpoint of preserving a specific complex of natural landscape elements within an integrated development plan.

The strategic multiple-use natural areas shown on Map 6-5 (areas 1 and 3b) have been selected on their physical characteristics without regard to ownership and regulation. Included in the designated areas are lands under both private and public ownership. Context 5 indicates the measures to be taken immediately to hold these areas until the protection programs of Context 3 are fully and effectively implemented. In establishing the protection legislation, the Indiana legislation discussed early in this chapter should be carefully analyzed for application to the Ontario scene.

The map shows only the present major urban and recreational areas; it does not indicate proposals for expansion. These uses, too, have their strategic location. However, transportation corridors and urban nodes can be planned with a view to preserving blocks of land which have strategic non-urban value.

This map, which places all the region's non-urbanized land in one of the five natural land uses, was designed to assist in planning urban expansion. All the land was included because there is no non-urban area in the whole of southwestern Ontario which does not have strategic value in the context of an ever-increasing urban pressure. This means also that as portions of these areas are diverted to other uses, the remainder has a higher strategic value, unless the area is so broken up it fails to operate as a natural ecosystem.

The main objectives implicit in the goals expressed by the scenario are highlighted below.

i) Strategic Multiple-Use Natural Areas. All areas 1 on Map 6-5 should be reserved at all costs without reduced acreage.

ii) Strategic Agricultural Landscapes (Areas 2 and 3 on Map 6-5).

iii) Strategic Open Space Landscapes of (3a) Agricultural Areas and (3b) Natural Areas.

Although there may be little differences in the priority rating of those agricultural areas designated 2 and those designated 3a, there is a significant difference in the priority of multiple-use natural areas designated 1 and 3b. Areas number 1 on the map are of highest priority because of unique features which cannot be replaced. No alternative uses should be planned for any part of these areas. The special value of areas designated 3b is only moderately high. However, these areas combined with agricultural areas 3a constitute a landscape of such diversity that the total landscape has a higher rating than the 2 landscapes when the demand for natural landscape experience is higher than that for food.

In anticipation of a demand for total open space production (both natural areas and agriculture) rather than one for food production only, the following appears to be a rational assumption for a correlative apportionment for development.

First, all of the multiple-use natural areas of top priority (the 1 areas) should be reserved — in any scheme.

Second, at least half of the multiple-use natural areas of moderate potential located within diverse open space landscapes (the 3b areas) should be reserved.

Third, in addition to the agricultural land associated with the selected 3b natural areas *(i.e.,* about half the 3a areas), a considerable portion of the 2 areas will be required to make up a total of not less than half of the strategic agricultural lands shown on the map (*i.e.,* half of all the 2 and 3a areas).

Key to Scenario (Map 6-5)

Only the full numbers, 1 to 7, are used on the map to indicate the main strategic types. Subdivisions of these types such as 1(a), 1(b) etc., are used in the text merely for convenience in listing.

1. Strategic Multiple-Use Natural Areas

Complexes of two or more of the following:

a) Ecological reserves: Preservation of natural gene pool.[12]

b) Extensive open space recreation

i) Natural-environment experience
Outdoor existence
Learning: Natural history, outdoor museums, collecting trophies, etc.

ii) Travel and viewing; land travel, water travel

iii) Hunting

iv) Fishing

c) Waterfowl habitat

d) Conservation of soil, water and landform

e) Timber production

2. Strategic Agricultural Landscapes

Strategic areas because of need for open space and for agricultural production.[13]

a) Strategic natural vegetation areas (not shown on map) include:

i) Multiple-use forests on all stream courses

ii) Systems of woodlands providing landscape esthetics and wind-breaks on a community basis.

iii) Farm woodlots. If not a part of previous group (ii), they must be on land highly suitable for multiple-use forest. (See detailed suitability map.)

3. Strategic Open Space Landscapes

Strategic areas because of need of open space, agricultural production, landscape esthetics and soil and water conservation.[14]

a) Intensive-use agricultural land

b) Multiple-use forest land

4. Strategic Reserves of Construction Materials

General area outlined on map: specific location to be designated by specialists in this field. (See discussion of Hagers-

ville and Paris Landscape Units, under "Description of the Natural Landscape Units of the Study Area".)

5. Strategic Multiple-Use Parkland
Areas having an attractive relief and/or in close proximity to either Lake Erie or the Grand River, suitable for low-density residential areas. Landscaped subdivisions and wooded parks within such landscapes will preserve their uniqueness and make available optimum living space for workers in intensively industrialized and commercialized areas such as Hamilton, Brantford and those areas developing within the Study Area. Map 6-5 indicates suitability only; feasibility has yet to be determined.

6. Present Urban Areas
No attempt has been made to designate most suitable centers of urban development. However, these should be carefully considered within the context of strategic landscape features.

7. Intensive Recreation Areas
Only the presently established intensive recreation areas are shown on Maps 6-4 and 6-5. No attempt has been made to designate additional areas.

The preceding scenario is both a summary and an introduction, a prelude as well as a finale. It summarizes the forest land-use appraisal but it is also one of the preludes to planning.

The Scenario: A Summary of Forest Land Appraisal
The scenario draws together, in summary form, those features of greatest significance in the development of the area's natural and human resources which depend on production from natural and semi-natural areas.

Using the perspectives of land-use ecology, all the individual areas have been evaluated, not only in the light of their own intrinsic worth, but also their extrinsic value as part of larger patterns at several levels of generalization.

Admittedly, the scenario is an extensive summary which requires much study because of its multi-dimensional nature. At the risk of over-simplification, the following highlights have been extracted in the hope that they will stimulate further examination of the scenario and the supporting background material.

1) The soil and climate of the Haldimand-Norfolk region constitute a potential resource which places the Study Area well above average in the scale of biological productivity for the province of Ontario.

2) At the time of settlement, the Study Area had a rich flora and fauna reflecting the potential of soil and climate. In the post-settlement period, rural sprawl made serious inroads into the natural landscapes; farm landscapes developed on only the better clay and loam lands. However, during the last 45 years, much of the Norfolk sandy land has been developed for tobacco production. Most of this land has also a high potential for corn production, thus providing an alternative to tobacco, should this industry decline.

3) At present, the potential of the land for agricultural, forest and natural-area land uses is not fully developed. Underdevelopment is due to such factors as the over-abundance of land in Ontario, the lack of economic pressure to develop large efficient farm units, and the lack of social pressure to preserve and develop natural areas.

4) At the present time, the production of timber in the Study Area is seldom profitable if the cost-benefit ratio is measured only in dollars and cents. The main exception to this is walnut, but its profitable production is limited to a very small percentage of the total area on both a farm and community scale.

5) The present relatively high percentage of land in Norfolk County under forest land use, including many pine plantations, has been retained largely because of county trees conservation bylaws. These bylaws require that currently forested land be retained in forest cover, presumably for the benefit of society at large even when it would be to the advantage of the individual to obtain greater financial returns from some other use.[15]

6) Although there are relatively large acreages of land covered by natural or semi-natural vegetation, the total acreage on which there is a full complement of the original natural species is extremely low.

7) There is an ever-increasing acreage of natural landscape being irrevocably changed. Advanced technology, involving both machinery and chemicals, is being used extensively in the development of land for agricultural, urban and transportation uses. This development includes the draining and filling of bogs, levelling of valley and hill lands, the disturbance of the productive surface soil, and is thus contributing significantly to the reduction of the diversity of natural landform. This development also reduces the acreages of strictly natural vegetation and increases losses of plant and animal genes.

8) The present interspersion of farm and forest land in the sandy areas of Norfolk County constitutes a pattern most favorable to the protection of the fields from wind erosion and provides a

landscape which requires little improvement from the standpoint of esthetics.

The Scenario: A Prelude to Planning

This scenario is presented as one of the preludes to the economic and socio-logical analysis which is being made to determine the most desirable use for each section of the Study Area. The scenario highlights some of the areas which will be required to provide the people of the region with a high quality environment. These are the areas having the highest relative suitability for multiple-use natural areas, taking their potential and present conditions into consideration. For this reason the reservation of these areas should be a goal in any recommended development program. (Before listing the specific recommendations, it should be noted that an important factor in implementing them will be the establishment of a system of municipal government for the Study Area that will have a clearly defined jurisdiction over regional matters.) The following are some of the specific recommendations which develop from the scenario.

1) a) Land-use decisions at local, regional and provincial levels should be based on political, legal and social rationality, as well as on those of economics and technology.[16]

b) An ecological perspective should be used in making such value judgments. This means that decisions regarding parts of a whole (*e.g.*, a rural area within a region, a region within a province) should not be made independent of the needs of other parts and of the whole.

2) Areas designated as strategic multiple-use natural areas numbered 1 on the scenario (Map 6-5) should be reserved for that use in the comprehensive plan.

3) The assignment of other uses of the remaining strategic open space landscapes (*i.e.*, those numbered 2, 3a and 3b on the scenario, Map 6-5) should be made in such a way that large blocks will remain inviolate.

4) Specific effort should be made to preserve as open space for natural-environment experience and for food production the following:
a) the Grand River valleylands.
b) Long and Turkey Points and a narrow zone along the entire Lake Erie shoreline.
c) a large block of agricultural and multiple-use natural areas in the greater proportion of Norfolk County. (This would exclude major transportation routes, large urban and industrial centers from that area.)

5) a) The proposed Buffalo-Detroit corridor should be routed along the Welland River, crossing Grand River near Caledonia, then passing south of Brantford to join the Macdonald-Cartier Freeway near Woodstock — thus circumventing the biologically rich valleys and plains of Norfolk and East Elgin and the broad clay farmlands of Haldimand.
b) Development in the Nanticoke area should be restricted to the type of large industries already entrenched. The opportunity for major urban developments should be provided in the Buffalo-Detroit corridor along the Grand River around Cayuga.
c) An efficient transportation corridor should connect the industrial complex in the Nanticoke area with the present and proposed urban areas along the Buffalo-Detroit and Grand corridors.

6) Development of the multiple-use parkland areas should be restrained until an integrated plan of multiple-use is implemented which will protect, through natural vegetation, the environmental quality of ravines and other valley slopes, bottomlands, prominent ridges and lake headlands.

7) The three levels of control for the preservation of strategic areas advocated by the Niagara Escarpment Study, Conservation and Recreation, Ontario Government, June 1968, (Section 4.3, p. 24) should be used by the appropriate authorities to reserve the strategic areas recommended in the scenario.

8) Those departments of the Ontario and Canada governments concerned with natural resources management on both public and private lands should develop more comprehensive guidelines for the management of multiple-use areas, particularly natural areas and ecological reserves.

As a concluding comment, the authors believe that the goals set forth in *Design for Development 1966,* which was quoted at the beginning of this chapter, should be transcribed into specific objectives relevant to the potential of regional resources and to the needs of the people at the local, regional and provincial levels.

Footnotes/References

Footnotes

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11. The nature of the amenities which the natural environment provides and their role in the present and future well-being of the province was discussed earlier in this chapter under "The Role of Forest and Other Natural Vegetation in Regional Development".
12. In many of these areas there are rare species in danger of extinction if their location is too definitely pinpointed. Therefore, it is suggested that a "back-office" land-use plan of all strategic multiple-use areas be made with documentation by all specialists involved to eliminate conflict of uses within these vulnerable areas. Such a plan should not be publicized for this would likely result in desecration.
13. This plan is to be integrated with the recommendations made in Chapter 7, Agricultural Land Use.
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Graham D., Agricultural Representative, Brant County, Brantford, Ontario.
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The Soils of Haldimand-Norfolk Region

The soils of Haldimand and Norfolk Counties were mapped in 1935 and 1928 respectively and the only soil maps available date from that time. Obviously there have been changes in soil mapping and soil correlation since then. The soil map accompanying this chapter includes some changes made during the month of August 1969, to bring it up-to-date.

The soil map carries as much detail as is possible within the limitations of scale. Areas less than 25 acres in size are not likely to be shown. Therefore, the map is a useful planning tool but is not adequate for management purposes. When it becomes necessary to decide the management to be employed for a particular area a much more detailed map must be made if soil is a consideration in the management plan.

In the report that follows, brief descriptions of the various soils are given. These are descriptions of the soil series and not of the cartographic units. The symbol within each map unit indicates dominance. Up to 25 percent of each soil area shown on the map can include other soils. The report also includes interpretive classifications which indicate the potential of each soil for a specific use. These classifications and the accompanying maps will likely be of greatest interest to the planner.

The soil descriptions and the acreages given for each soil series apply to the two counties of Haldimand and Norfolk only.

Soil Series Descriptions

Berrien Series

Berrien sandy loam is a soil developed on undulating shallow outwash deposits of sandy loam, less than 3 feet deep over heavy impervious clay and is the only soil type in the series. The drainage is variable, depending on the depth of sand but is usually imperfect.

The nature of the soil layers varies with the depth of sandy loam over the clay. On the deeper knolls the surface soil is generally a grayish-brown sandy loam 4 to 6 inches thick, underlain by a loose yellowish sand or sandy loam. A third layer of yellowish gray sand or clayey sand highly streaked and mottled with reddish brown stains is underlain with heavy gray impervious clay. The depth to the clay has a profound effect on the profile development of this soil. The shallower the sandy deposit, the closer to the surface the mottlings occur. The organic matter content ranges from low on the knolls to medium or high in the basins.

The upper layers are generally medium to strongly acid, depending on the depth of the sand over the clay. The Barrien is typically a stonefree soil.

The clay may appear at or near the surface in some included areas whose characteristics approach those of the Caistor clay loam and Caistor loam. Other frequent inclusions are low-lying areas similar to the Wauseon and Granby series and more undulating areas where deep sands on the knolls are characteristics of Fox soils.

Location and Extent.

The largest areas of this soil lie east of Dunnville, west of Port Dover, south of Tyrell and near Hartford. Other areas occur in Cayuga and Walpole Townships and close to Waterford. The total area is approximately 15,800 acres.

Topography and Drainage.

The topography is undulating to gently rolling. While the surface drainage on the knolls is generally good, the underlying impervious clay obstructs the internal drainage. The drainage in the lower lying depressions is poor. Intermediate areas are imperfectly drained and these occupy by far the greatest part of the lands shown as

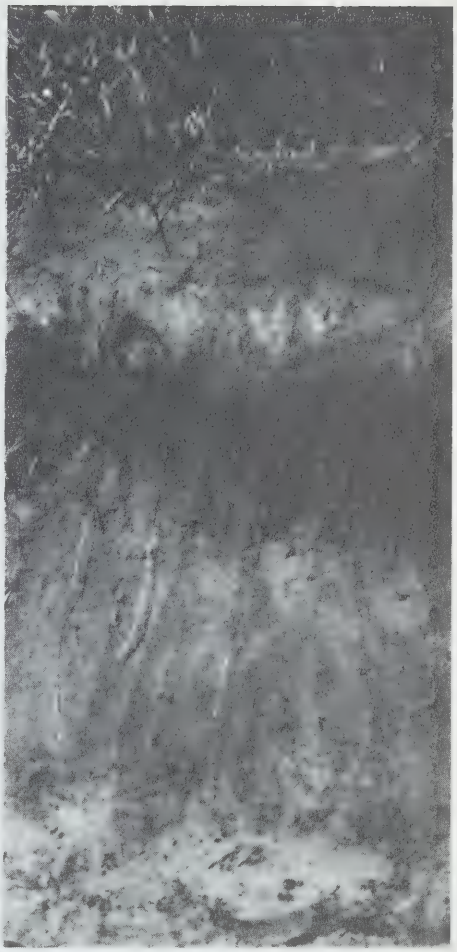

Figure 7-1/Berrien sandy loam consists of medium and fine sands underlain by clay materials. Here the clay is the light-colored material at the bottom of the photograph. The clay obstructs drainage and interferes with certain uses.

Berrien on the map.

Native Vegetation.

On the better drained knolls, beech, hard maple, birch, white pine and elm are commonly found. On the more poorly drained areas, elm, red maple, ash, red oak and pin oak occur. Red top grass and Canada blue grass are the dominant species in the old natural pastures.

Agriculture.

A large proportion of the area is under cultivation and when properly managed is suitable for the production of grain, hay and corn. Small fruits and other canning crops can be grown on the better drained areas. There are large areas in bush and permanent pasture.

The productivity of the pastures is generally poor.

The fertility and reaction of this type are as variable as the drainage. On the average, the natural fertility is only medium. The better drained parts of the area are medium to low in fertility and moderately to strongly acid in reaction. The organic matter content is fairly low and the nitrogen supply often deficient. The levels of available phosphorous, potash, calcium and magnesium are low.

Bottom Land

This soil is found in the valleys along the stream courses. It is constantly being changed by additions and removals of sediments which occur every time there is a flood. Composed of materials recently deposited, the profile has practically no regular differentiation. The surface soil is quite dark, having a fairly high organic matter content. The underlying soil is usually highly mottled, indicative of poor drainage. The reaction is usually neutral to alkaline. In texture it ranges from a sandy loam to a silt loam. Bedrock, marsh and muck are a few of the many inclusions in this cartographic unit.

Location and Extent.

Occurring on the flood plains and low lying lands along the streams, it has a scattered distribution. These areas cover approximately 28,300 acres. In many places along the stream courses there is not enough of it to show on a small-scale map.

Topography and Drainage.

The topography is flat to slightly undulating. The drainage is poor to medium, depending partly on the fluctuating height of the water in the streams. Much of it is flooded in the spring break-up or after an exceptionally heavy rainfall. Included marsh and muck areas commonly have a high water table.

Native Vegetation.

Willow, elm, soft maple, alder and bulrushes are common.

Agriculture.

This soil is used mostly for pasture. Some of the better areas under favorable climatic conditions produce good crops of corn, cereal grains, hay, etc. The best use of this soil would appear to be reforestation and pasture.

Brant Series

Well drained soils developed on calcareous loam or silt loam materials make up the Brant series. These soils consist of a surface (Ah) layer dark grayish brown loam in color, 6 to 18 inches deep, underlain by a leached layer (Ae horizon) brown in color which becomes paler with depth. The Ae horizon is 14 to 20 inches thick and is underlain by a B horizon of dark silty clay loam 8 to 12 inches thick. The gray calcareous C horizon occurs at depths of 36 to 50 inches.

In some parts of the areas mapped as Brant loam sandy knolls occur and there is also an occasional deposit of gravel.

Location and Extent.

Brant loam occurs mainly in two fairly large areas — one north and west of Simcoe in Windham and Townsend townships, and one west of Carholme in Walsingham Township. There is a smaller area near Walsh in Charlotteville Township. Brant silt loam covers two large areas in Norfolk County, one from Townsend Centre northward through Boston to the Brant County boundary and the other from Simcoe to Vittoria and down toward Port Ryerse. There are also a couple of smaller areas near Wyecombe.

Topography and Drainage.

The topography is quite rolling and in some places hilly. The natural drainage is good.

Native Vegetation.

Nearly all of this soil is under cultivation but, judging from present tree cover, it once supported vigorous stands of oak and pine.

Agriculture.

It is well adapted to the growth of canning crops such as corn, tomatoes, peas and small fruits, as well as tree fruits, cereal grains and clover.

Brantford Series

The Brantford are rolling stonefree (lacustrine) soils with fairly good natural drainage.

The surface is a grayish brown soil commonly a clay loam in texture but often somewhat silty in nature. It is commonly 5 to 6 inches thick. The second layer Ae is a yellowish gray clay, clay loam or silt loam 5 to 7 inches thick. A heavy compact dark brown clay layer B 8 to 10 inches deep is found just above the C horizon. The C horizon consists of strata of clay and silt deposited by the water.

The Ah and Ae horizons are moderately to strongly acid except where erosion has taken place. The B horizon is about neutral while the underlying parent material is alkaline.

The soil layers and parent material are generally stonefree throughout. In some places the stonefree deposits may be somewhat shallow and underlain by stony till.

This soil suffers from sheet and gully erosion to as great an extent as any soil in the area. The underlying strata offer little resistance to the power of water and stream courses are cut deep into the rolling terrain. Consequently, much of the two top layers has been removed and hard brown clay knolls are common along stream courses and other slopes.

Location and Extent.

The only area of Brantford clay loam mapped is in the extreme northwest of Haldimand County adjoining Brant County, and covers approximately 3800 acres.

Topography and Drainage.

The topography is rolling with steeper slopes near stream courses. The surface drainage is good.

Native Vegetation.

The common association on this type is beech-maple. Other trees are white pine, elm and oak.

Agriculture.

Much of the Brantford clay loam has been cleared and is used for cereal, hay and pasture.

The fertility levels of this soil are fairly good. The main requirements are organic matter and phosphate. The levels of potash and calcium are medium and magnesium is high.

The best cultural practices for this type must include measures for the control of erosion.

Brookston Series

Brookston soils are poorly drained and developed on gray clay loam or clay till like that of the Huron and Perth soils. Brookston clay loam is the only soil type mapped and it occurs only in Norfolk County. The surface layer consists of dark gray or black clay loam, high in organic matter and from 6 to 9 inches deep. This is underlain by gray clay, mottled with reddish brown or rusty brown colors. Mottling intensity varies and it may be evenly distributed throughout the profile or concentrated in a band usually in the lower part of the profile. The C horizon is calcareous and is located about 34 inches below the surface. The surface is usually neutral to alkaline throughout.

There are a few small scattered sandy knolls included in the area mapped as Brookston clay loam.

Extent and Location.

This type covers most of the east half of Townsend Township, a large area in the south part of Woodhouse Township and a few other scattered small areas.

Topography and Drainage.

The topography is flat to undulating and the natural drainage is poor. Tile drains are being used with excellent results on most of the area.

Native Vegetation.

The forest growth, where it still remains, consists mainly of elm, soft maple, ash, hickory, basswood and swamp oak.

Agriculture.

Most of the area is under cultivation and produces good yields of farm crops. Hay, pasture and some canning crops being produced on areas of improved drainage.

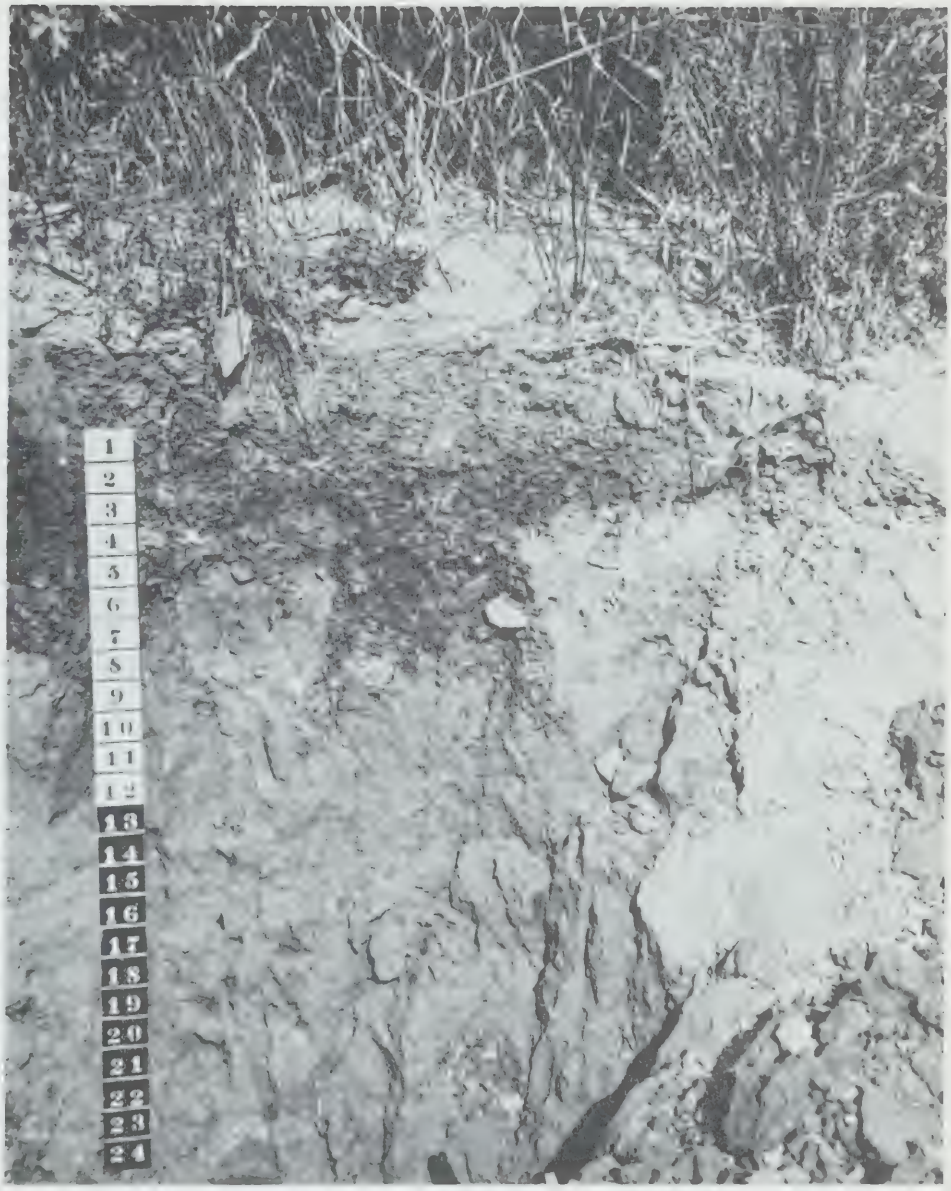

Figure 7-2/Drab gray colors and a dark surface are characteristic of poorly drained soils. This Brookston clay loam would be more reliable for most uses if tile drained.

Caistor Series

The Caistor soils are gray acid imperfectly drained soils with gently undulating topography.

The surface soil is a dark grayish brown clay or silt loam about 5 or 6 inches thick and commonly low in organic matter. The second layer is grayish brown clay or silt loam highly mottled with ochre-brown spots. When present, the mottling is invariably found in the lower parts of this second layer and frequently occurs immediately underneath the surface. On the better drained locations are included areas where the soil layers approach those found in the Haldimand clay loam. The underlying unweathered material is similar to that of the Haldimand clay — a compact gritty clay with local deposits of stonefree clay. The two large areas of Caistor clay loam in Sherbrooke and Dunn Townships are more generally of a lacustrine stonefree nature. Commonly, however, there are small stones or grit in the subsoil and occasionally a few larger stones and boulders are also found. Silty knolls are

Figure 7-3/These are clods of A and B horizons of Caistor clay. The darker B layer has a high clay content and tends to become massive in structure when worked in a wet condition. Lack of permeability then restricts moisture movement and root growth.

common inclusions in this type in Canborough and Moulton Townships.

The Caistor is the moderately poorly drained associate of the Haldimand clay. Indeed, separation of these two soils sometimes is difficult especially when they occur side by side.

Location and Extent.
Caistor clay loam has the same general distribution as the Haldimand clay except that it is found only in Haldimand County. It covers an area of approximately 15,400 acres.

Topography and Drainage.
The topography ranges from slightly undulating to almost level. More level areas occur in Sherbrooke and Dunn Townships. Pond holes and small depressions are common throughout the area. The drainage is commonly fair to poor. Artifical drainage is essential for crop production.

Native Vegetation.
Elm is the predominating tree species while swamp white oak, shagbark hickory and red maple are abundant. Other trees occurring in considerable numbers are hemlock, pin oak, white pine, blue beech, grey birch and ironwood.

In natural pastures Canada bluegrass is the dominant pasture grass. In many pastures weeds are abundant. The dominant common weeds and other herbs are yellow cinquefoil or crowfoot daisy *(Potentilla recta),* devil's paint brush, king devil, wild carrot, chickory, common St. John's wort and tall daisy fleabane. Everlasting *(Gnapalium)* is common on the silty knolls.

Agriculture.
A large proportion of the Caistor clay loam areas is still forested. A considerable area is also in natural pasture. Under improved drainage conditions, cereal (oats, mixed grains and, to a lesser extent, wheat) and hay crops (timothy, clover and, to some extent, alfalfa) are grown.

On account of the poorer drainage, this soil requires even more careful management than the Haldimand to prevent puddling and baking. Otherwise, good farm practices are the same on both types.

Colwood Series
The Colwood soils are characterized by their almost level topography, poor natural drainage, and the high organic matter content of the surface soil.

They have been derived from stonefree loamy lacustrine deposits under drainage conditions which favor the development of a high organic matter content.

The Colwood soils have a black or dark brown loam or silt loam surface horizon (Ah) 5 to 12 inches thick. Underlying this is a gray mottled loam which ranges widely in thickness but has an average depth of about 18 inches. The upper part of this layer is frequently stained with yellow and brown and the lower part is generally strongly mottled. The C horizon ranges from a light brown to gray fine sandy loam to a gray silt loam.

Location and Extent.
The Colwood soils occur near Lowbanks in Moulton Township and make up the

major part of areas shown as mixed water soaked loam (Mw) in Norfolk County. They occupy about 5500 acres in the Haldimand-Norfolk region.

Topography and Drainage.
The topography is almost level. The natural drainage is poor, and the water table is at the surface almost ten months of the year.

Native Vegetation.
Elm, ash, white birch, soft maple are some of the common trees on this type.

Agriculture.
Second growth scrubby timber covers much of the Colwood series. Permanent pastures are common. Hay and pasture are the chief crops. Grain and silage corn are grown to some extent. Tomatoes and other canning and truck crops are locally important crops, but only where some form of artificial drainage has been installed.

Eastport Sand
This soil is found along the shores of Lake Erie where the wind has piled up sandy beaches and dunes. Drifting is common. Since there is little stabilization, there are practically no soil layers. There may be a little accumulation of organic matter on the surface but there is little difference between that layer and the underlying loose gray sand. The reaction is usually alkaline.

Location and Extent.
There are approximately 300 acres of this type along Lake Erie, chiefly at Evans and Grant Point and near Port Maitland at the mouth of the Grand River.

Native Vegetation.
While the vegetation is usually scant on account of the drifting sand, willows, pines and oaks grow in the more protected areas.

Agriculture.
This soil is little used for agricultural purposes owing to the low fertility and the steep, open nature of the soil. The best use is for recreation.

Farmington Series
The Farmington soil is a shallow layer over limestone. It has developed from a deposit of loam till less than 12 inches thick over the bedrock. Shallowness prevents much differentiation into soil layers but two are present wherever the soil is deeper than 6 inches. The surface soil is usually a dark brown, very friable loam, alkaline in reaction and quite low in organic matter. A brown horizon (Bm) occurs just above the rock. Much of the land mapped as Farmington has less than 6 inches of soil over the bedrock and in places there is no soil covering at all.

Location and Extent.
The three largest areas of Farmington loam occur west of Springvale, near Hagersville in Walpole Township, and northwest of Decewsville in Oneida and Cayuga Townships. Smaller areas, many too small to map, occur generally throughout the southern part of Haldimand County from the Norfolk boundary to the mouth of the Grand River. None have been mapped in Norfolk.

Topography and Drainage.
The relief is necessarily the same as the bedrock. In general, it is flat to gently undulating. The internal drainage is impeded by the rock and the rate of percolation depends on the nature of the cracks in it. Hence the soil is often too wet at one time and too dry another. Poorly drained basins occur in shallow depressions in the rock floor.

Native Vegetation.
The dominant tree on this shallow soil type is the red cedar *(Juniperus virginiana)*. American elm and cork elm are sparsely distributed. The chief grasses in the permanent pastures are Canada blue and redtop.

Agriculture.
Much too large an area of this type has been cleared for little of it is now cultivated. Most of the area is either in pasture or abandoned. It has little agricultural value but can be used for grazing.

The physical characteristics of these soils are responsible for their limitations. Chief among these is the effect that a shallow layer over rock has on the water content of the soil. In general, the soils are very droughty although at times of heavy rainfall they are too wet.

Fox Series
Fox soils consist of a surface soil of grayish brown, fine sandy loam, sandy loam or loamy sand, 5 to 7 inches thick, underlain by a brown, friable sandy loam or loamy sand 12 to 20 inches thick, which becomes yellowish with depth. These horizons are underlain by a dark brown loam or clay loam B horizon 6 to 10 inches thick which grades abruptly to medium, pervious gray sand or sand and gravel.

A distinguishing characteristic of the Fox soils is the dark brown clayey layer. The percentage of clay may be small but is sufficient to bind the coarser material into a coherent mass and to render this layer less pervious and more retentive of moisture than the material above or below it. The A horizons are medium to strongly acid, the B horizon nearly neutral and the parent material high in carbonates and alkaline.

Location and Extent.
About 71,000 acres of these soils are found in Woodhouse, Windham, Townsend, Charlotteville and Middleton Townships. Fox sandy loam, Fox fine sandy loam and Fox loamy sand occupy a large part of these townships but are not found in Haldimand County at all.

Topography and Drainage.
These soils occur in various water-deposited landforms including outwash plains, deltas and beaches. The topography is gently undulating and the drainage is good.

Native Vegetation.
The stump fences and woodlots which are found on these soils indicate that there was once an abundant growth of pine. At present there are a number of pine plantations and woodlots of oak, beech, and a few butternut. Most of the area is cleared and used for agriculture.

Agriculture.
The most important cultivated crop grown on these soils at present is flue-cured tobacco. Canning crops such as tomatoes, corn and small fruits are also grown with the greatest production usually occurring on the Fox fine sandy loam and sandy loam soils. Grain, hay and grain corn are produced with success on the Fox fine sandy loams but seldom grown on the loamy sand.

In general the Fox soils have a low fertility. Phosphorus, potassium and nitrogen are low as is the organic matter content. In addition these soils are droughty for all or part of the growing season and supplemental irrigation is needed for most crops. When adequate amounts of water and fertilizer are applied these soils produce good yields of fruit and vegetable crops.

Gilford Series
Gilford soils occupy only a very small part — 240 acres — of the region and their agricultural value is low. The Gilford loam mapped here is unlike that mapped in other regions. It consists of a surface layer of dark grayish-brown gravelly loam 6 to 8 inches thick and underlain by a gravelly loam 12 to 18 inches deep, gray in color and mottled with rusty brown or reddish splotches. The C horizon is of grayish gravel, high in lime; heavy impervious clay occurs not far below. There are many stones and boulders scattered over the area. The profile is neutral to alkaline throughout and the organic matter content is fairly high.

Location and Extent.
Only one tract of this type has been mapped in Norfolk County near Bookton.

Topography and Drainage.
The topography is flat and the natural drainage is poor. Under natural conditions the lower layers are waterlogged much of the time, but with proper ditching or tile drainage the water table is lowered so that the soil is fairly well adapted to the growing of farm crops.

Native Vegetation.
The forest growth is somewhat similar to that of the Brookston clay loam, with elm and soft maple predominating.

Agriculture.
This soil has a low agricultural capability but can be used for cereal grains and corn when drained artificially. Liming is not necessary and drainage should be looked after before there is any large investment in fertilizers. On the better-drained areas fertilizers containing phosphorus and a small amount of potash and nitrogen should give good results. Farmyard manure or green manures should be applied to keep up the organic matter supply.

Granby Series
Only one soil type makes up the Granby series mapped in the Haldimand-Norfolk region. The Granby sandy loam is a poorly drained soil development on outwash sand and sandy loam. The clayey substratum, if present, is at a much greater depth than in the Wauseon.

The surface soil is a dark gray sandy loam or sand 6 to 12 inches thick. Below this is a sandy loam continuing to a depth of 2 feet. The upper part is strained with yellowish brown, the lower part strongly mottled gray and rusty brown and in places soft rusty brown concretionary material is present. Below this is a gray and light brown sandy loam which may be interbedded with thin layers of clay and sandy clay. However, lower substrata are variable.

The organic matter content of the surface layer is naturally high, although under artificial drainage and cultivation this rapidly disappears. The reaction of surface is usually slightly acid to slightly alkaline. There are no stones in any of the soil layers.

Location and Extent.
The main areas of Granby sandy loam occur in Charlotteville, Moulton and Windham Townships and cover approximately 10,100 acres.

Topography and Drainage.
The topography is almost level. The natural drainage is poor. The water table can be fairly easily lowered as there are no heavy layers close to the surface.

Native Vegetation.
The common forest trees occurring on this type are elm, soft maple, ash and birch.

Agriculture.
A comparatively large proportion of this type has been left in forest scrub and permanent pasture. Hay is the chief cultivated crop. If well drained and well fertilized, this type returns good yields of truck crops of many varieties.

Apart from the high organic matter content, the level of available nutrients is fairly low.

Haldimand Series
The Haldimand soils are gray acid soils with fairly good natural drainage, developed on a rolling upland of ground moraine and water-deposited clays and sometimes containing a proportion of shale.

The surface soil is a light grayish brown clay or silt loam about 5 to 6 inches thick. The gray color which characterizes this in the field is due to its low organic matter content. The second layer (Ae) has 5 to 7 inches of light gray, mottled clay, often with a fairly high percentage of silt. A heavy compact dark brown clay layer (B) 8 to 10 inches deep is commonly found just above the C horizon. Another layer is frequently found just above the B and below the gray Ae. This horizon (the BA) is a pale brown mottled layer having characteristics of both the A and B horizons. The C horizon is usually a compact gritty gray clay. Lacustrine clay may occur in the C horizon just below the clay till. The A and B horizons of the profile may be derived from either till or lacustrine materials or both. Hence gritty material may be found in the upper soil layers but larger stones are seldom numerous.

Many streams have cut their courses through this soil. Consequently, much soil erosion has taken place and in many places the second and third layers and even the parent material are exposed at the surface. Good examples of this are found along the hillsides bordering any of the stream courses in this area. Streambank erosion has added to the amount of

sediment in the streams, and the sediment load is particularly heavy in the Haldimand clay plain where Haldimand soils predominate. Farmers often speak of the hard red clay knolls. These are merely exposures of the heavy reddish brown layer in the normal profile. In this soil type silty knolls are general inclusions. In Haldimand County the silty knolls do not commonly occur except in the northern part of Canborough and Moulton Townships.

Location and Extent.
Haldimand clay is the dominant type in the region and covers approximately 197,300 acres. It is generally distributed throughout Haldimand County excepting two large areas, one in the northwest and the other in the southeast. It occurs, also, along the eastern side of Norfolk.

Topography and Drainage.
The soil has been developed on ground moraine with undulating to slightly rolling topography, but has been eroded by streams so that there are now many fairly steep slopes bordering these streams. While the surface drainage is fair because of the numerous streams, the heavy impervious subsoil restricts the internal drainage, which is slow. Drainage, then, is imperfect but areas of moderately good drainage occur near some of the streams and rivers.

Native Vegetation.
Hard maple and beech are the chief components of the forests where there is better surface drainage. There is an almost equal area where American elm, soft maple, white oak, red oak and shagbark hickory are common, indicating that the impervious soil layers restrict internal drainage. White pine is abundant where there is a shallow surface deposit of silt or fine sand. It is not uncommon to see a stand of pine on an apparently heavy clay plain. Ironwood and hemlock are also common.

Canada bluegrass is the dominant species in nearly all the permanent pastures on this type. Weeds are common but not as abundant as on many of the clay soils. Upright cinquefoil *(Potentilla recta)* is a common weed in pastures and fence-rows.

Agriculture.
Most of the land has been cleared and is used mainly for grain, hay and pasture. The main cereals are wheat, oats and mixed grains, while those grown to a lesser degree are barley, corn and rye. A large acreage is devoted to cultivated hay, although the stands of clover are often poor. The acreage in orchards and market gardens is comparatively small.

These soils are often hard to work. They are of clay texture, acid in reaction and generally low in organic matter; they puddle easily under wet conditions; and bake to a very hard consistency when dry. Therefore, it is essential to plow in plenty of manure and crop residues to keep the soil in a good physical condition.

For years the Haldimand soils have been considered poor for growing fruit and vegetable crops but this is not completely true. Certain orchard crops such as apples, plums and pears, and most vegetable crops, would do well. What is required is more careful soil management and a ready market. Once a demand is engendered and processing plants built these soils can and will supply large amounts of special crops.

Huron Series
Huron soils are well drained, developed on calcareous clay loam till and have a profile somewhat thinner than the coarser texture of soils in the region. The surface layer is a dark grayish brown silt loam 5 to 7 inches thick. The Ae horizon is a pale brown to light gray silt loam 6 to 8 inches thick underlain by a dark brown B horizon. The C horizon is a gray clay loam or clay till.

Some of the knolls in mapped areas of Huron silt loam have a thin covering of fine sandy loam. There are some stones in the profile but they seldom interfere with cultivation.

Location and Extent.
There is only a comparatively small area of this type and it is found only in Norfolk County. It occurs along the ridges in the northwest corner of Windham Township, along the Goshen road between Courtland and the Elgin County boundary, and in the corner southwest of Tillsonburg.

Topography and Drainage.
The topography is rolling to hilly. The surface drainage is good in all parts of the area except in small local depressions, where there may be pond holes or small included areas of muck soil.

Native Vegetation.
Hard maple was the dominant tree species on this soil at one time with elm in a few places.

Agriculture.
Huron soils are used principally for dairying and mixed farming. Grain corn, cereal grains, hay and pasture are the crops most often grown and yields are usually high. The steep slopes over part of this soil erode rather easily and management must include certain erosion control methods.

Jeddo Series
Jeddo soils are dark acid soils developed on smooth, poorly drained areas of clayey ground moraine and water-laid sediments similar to those in the Haldimand and Caistor areas.

The dark surface soil is high in organic matter and is underlain by a gray plastic clay highly mottled with reddish brown. The topography is level and the natural drainage poor.

Location and Extent.
Two small areas of Jeddo clay were mapped in Haldimand County; one is in Dunn Township near Lake Erie, and another in South Cayuga not far from the Grand River. None was found in Norfolk. The total is approximately 380 acres.

Agriculture.
Little of this type has been developed as it not only requires drainage, but heavy applications of lime and phosphate to make it productive. The better features are its relatively high potash and organic matter content.

Muck
Under present conditions the muck soils are comparatively unimportant. They occupy 3600 acres in addition to about 400 acres of the areas called Colwood-Muck soil complex.

The black, partially decomposed organic matter varies in depth from about a foot to 3 or 4 feet. The materials underlying these muck deposits are varied in nature. In some places there is a layer of marl — a white or gray lime-like material which is mostly calcium carbonate and contains numerous small shells. In other places there is a compact clayey sand which has a mottled gray and rusty yellow color which grades into a gray water-soaked sand or sandy clay.

The reaction is sometimes slightly acid at the surface but is usually neutral to alkaline throughout.

Extent and Location.
The muck soils occur in small scattered areas in Middleton, Windham and Townsend Townships, in low flat areas which have been very poorly drained for a long time. The two largest areas are found about 1 mile northeast of Courtland and about 2 miles south of Windham Centre. Only one area occurs in Haldimand County and this is located on the east side of Sherbrooke Township.

Topography and Drainage.
The topography is flat and the drainage very poor.

Native Vegetation.
The natural vegetation is somewhat similar to that on the poorly drained sandy soil types, consisting largely of alder, elm, poplar, soft maple, etc.

Agriculture.
Very little agricultural use has been made of these muck soils except for pasture although, on occasion, they have been used to grow vegetable crops. Considerable reclamation is required before these soils can be used for vegetable production. Water control is of prime importance and so drains are needed to get rid of excess moisture. Once drains are installed it is necessary to provide irrigation water and large amounts of commercial fertilizer.

Onondaga Series
The Onondaga soils are well developed on lacustrine silty clays.

The surface soil (Ah) is a gray to light brown clay loam layer about 5 to 6 inches thick. The organic matter content is fairly low. The second layer (Ae) is grayish clay loam 5 to 7 inches thick overlying a dark brown clay layer about 6 to 8 inches thick. The C horizon is a stony dark grayish brown silty clay and silt loam. Stones are not found in any of the soil layers but are common on the surface of some fields. The surface and second Ae layers are moderately acid; the brown B neutral and the C horizon are alkaline, with free carbonates appearing at 16 inches.

Location and Extent.
Onondaga clay loam covers approximately 51,200 acres or 17 percent of the land area of Haldimand County and is not mapped at all in Norfolk. It occurs chiefly in the rolling, northwestern section of Haldimand on either side of the Grand River from Caledonia to a point south of Cayuga extending westward north of Hagersville to Springvale.

Topography and Drainage.
The soil has been developed on rolling to hilly lacustrine silty clays which owe their steep slopes to dissection by present-day streams. The drainage is good.

Native Vegetation.
The more pervious subsoil of the Onondaga clay loam as compared with the Haldimand is reflected in the natural flora of the two types. Maple, beech, red, white and black oaks, butternut, walnut and hickory are found in greater numbers while elm and soft maple are much less common.

Agriculture.
This soil is used mainly for grain, hay and pasture production. The main cereals are wheat, oats, mixed grains, corn and barley. The acreage in wheat is usually higher on this type than on the Haldimand, probably because of the better natural drainage. This soil is well adapted to alfalfa and to a lesser extent to clover.

The organic matter content is low and the nitrogen level is often inadequate. The upper soil layers are moderately acid and free carbonates do not occur within 16 to 20 inches of the surface unless erosion has taken place. The levels of available phosphorus are low, potash medium to high, calcium medium and magnesium high.

The plowing down of green manures, particularly clover, should give excellent results. Phosphatic fertilizers are one of the main requirements.

Ontario Series
The Ontario soils are well drained acid soils developed on rolling and drumlinoid moraines containing a fairly high proportion of shale along with limestone and sandstone.

The surface soil is a light brown loam 5 to 7 inches thick. The organic matter content varies from low to medium. The second layer (Ae) is a grayish loam 5 to 10 inches thick. The B is a reddish brown loam or clay loam 4 to 6 inches thick. The underlying C horizon is light brown to reddish brown stony loam containing a large percentage of shale fragments intermixed with the limestones. Sandstone fragments also occur. Stones are common in all the soil layers. Small gravelly areas frequently occur. The surface and second layer is moderately acid but commonly the underlying material is alkaline and has free carbonates.

Location and Extent.
The area of Ontario loam in Haldimand County is small, covering about 1900 acres; none is located in Norfolk. It occupies isolated ridges and elongated hills (drumlins), and is scattered throughout the Oneida clay loam area and to some extent the Haldimand clay area. The chief concentration of these patches, however, occurs just northwest of Cayuga, although the largest single area mapped is probably that occurring in Sherbrooke Township east of Port Maitland.

Topography and Drainage.
The topography is rolling to hilly. In places it may be described as drumlinoid, referring to the position on the oval enlongated hills which it commonly occupies. The drainage is generally

good, only occasionally rapid.

Native Vegetation.
The tree growth in the small woodlots consists chiefly of red oak, black oak, white oak, hickory, walnut, butternut, chestnut, beech and hard maple.

Agriculture.
As this soil commonly occurs in association with Haldimand soils, it might well be selected for orchard, garden and other crops requiring an earlier and better aerated soil. Woodlots are common on the steeper slopes.

The levels of available plant nutrients are only fair. The organic matter content is below medium. Since it is slightly to moderately acid, it may require lime to ensure good crops of legumes. The level of available phosphorus is low and that of potash and calcium medium to low. The magnesium level is generally high.

Perth Series
The Perth soils are fine-textured and developed on a fairly compact ground moraine with undulating topography and fair natural drainage.

The surface soil is a dark gray-brown loam, clay loam or clay 5 to 7 inches thick. The second layer (Ae) is a pale brown to light gray mottled loam or silt loam, 8 to 18 inches thick and underlain by a brown clay loam with reddish brown mottlings. The C horizon is a pale brown to gray clay till containing about 20 percent carbonates.

The Perth series, developed of materials similar to the Huron and Brookston series, has a range of topographical drainage and associated characteristics intermediate between these two types. Hence, the above description of the soil layers applies to this intermediate condition. There are, however, inclusions of soils similar to the Huron which has little mottling in the second layer and just below this a reddish brown layer (the B). There are also inclusions of soils where the second layer is usually mottled up to the surface soil which is usually fairly high in organic matter.

The reaction of the surface soil is neutral to alkaline. The alkalinity increases with depth. Free carbonates are found in the unweathered materials at 14 to 30 inches. The organic matter content of the surface is medium. Small stones or grit are common in the compact subsoil and a few larger stones and boulders are frequently found throughout the area.

The chief differences between the Perth and Haldimand are in their reactions, the alkaline reaction of the Perth making it a more desirable soil. In many respects — topography, drainage, etc. — the two soils are similar.

Location and Extent.
The only area of Perth clay loam in the region lies toward the north of Walpole Township across the Norfolk-Haldimand county line. It covers about 7400 acres.

Topography and Drainage.
The Perth clay loam has developed on an undulating upland of ground moraine. There are a few ponds and low swales included in the area mapped as Perth and here drainage is poor. However, most of the area shown as Perth is imperfectly drained.

Native Vegetation.
The greater part of the area has been cleared. Maple, elm and ash were the original forest growth. Natural pastures are not as common as on the Haldimand clay. There is also a larger percentage of Kentucky bluegrass in the permanent stands.

Agriculture.
This soil is well adapted to cereal, hay and pasture production. Clovers, wheat, barley and oats do well.

It is quite a fertile soil, being fairly high in available potassium, calcium and magnesium. It responds well to phosphatic fertilizer. Liming is unnecessary, as alfalfa and sweet clover generally thrive well. If local areas occur where clovers are not so thrifty, a check should be made of drainage.

Plainfield Series
These are the most common sandy soils in the Haldimand-Norfolk region. There are sand dunes and blowouts scattered among profiles that are somewhat more stable.

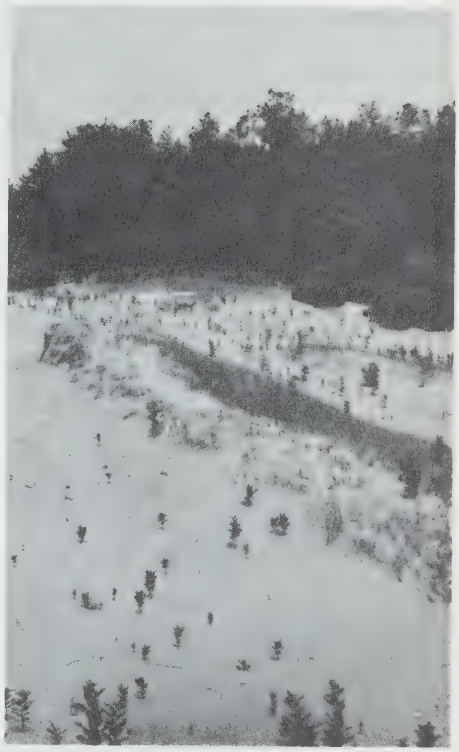

Figure 7-4/Blowouts like this were quite common on the Plainfield soils some years ago. Reforestation and the planting of windbreaks have reduced the erosion hazard.

A large part of the area is covered with vegetation which helps to keep the soil in place but when the vegetation is removed and the organic matter becomes depleted, the soil begins to drift. In these drifting areas the soil profile has no regularity except that the sand is loose and open, excessively drained, and low in organic matter. These areas are included with the Plainfield rather than typical of it.

The surface soil of the typical Plainfield is a light greyish brown sand or loamy fine sand 4 to 6 inches thick. This is underlain by 25 to 40 inches of loose yellowish sand which gets lighter in color at the greater depths, and grades into a loose, pervious, substratum of gray calcareous sand.

In some places there is a reddish brown layer just above the gray sand. Some of the deeper creek valleys have clay exposures along the lower parts of the hillsides. These are too narrow to show separately on the map.

The surface soil and leached layer

are quite strongly acid or, in other words, the soil is acid to a depth of 3 or 4 feet. In some of the sand dune areas the upper layers of soil have been removed by the wind and the gray sand substratum which is rich in lime is exposed at the surface. When this alkaline, gray sand is also spread around on the nearby soils by the wind, the lime slowly dissolves and diffuses through the soil, giving it an alkaline reaction. A good example of this is the area around Houghton Sand Hills. The soil which lies near these sand hills is neutral to alkaline in reaction.

Location and Extent.
This soil type occupies about half of Charlotteville, Walsingham and Houghton Townships, a smaller portion of Middleton and Windham and a few scattered areas in Woodhouse and Townsend Townships.

Topography and Drainage.
The topography is undulating to rolling and the drainage is rapid. In dry seasons the moisture supply is often the controlling factor in plant growth.

Native Vegetation.
The natural tree growth consists largely of pine, oak and sumac much of which was removed to make way for agriculture. However, subsequent wind erosion removed so much soil that windbreaks were planted and reforestation of certain areas with pine and spruce is still part of land management in many places.

Agriculture.
Plainfields soils are used mainly for tobacco growing. Some canning crops are grown, as are fruit crops. The main limiting factors to crop production are low fertility and low moisture supply but the soils have some advantages. They warm up early in the spring and are easily worked. For grain and hay production and general farming the value of these soils is low because of the high cost of irrigation and fertilizer inputs.

This soil has large requirements for organic matter, lime, and fertilizers. Tobacco requires heavy applications of commercial fertilizers and irrigation for best results. For canning crops it is necessary to keep building up the organic matter by means of barnyard manure, cover crops, etc., as well as using liberal quantities of commercial fertilizers.

Figure 7-5/Irrigation is necessary for tobacco on the dry sandy soils. The production of other crops raised on sandy sites would benefit from the use of additional water too.

Smithville Series
These are moderately well drained soils developed on the same gray, calcareous clay materials as the Haldimand. The surface layer (Ah) is gray brown silt loam or silty clay loam where the upper part of the profile has eroded away. Underlying the surface is a brown Ae horizon which becomes paler with depth and extends 7 to 12 inches to the top of the B horizon. At this point there is a change in texture and color which is rather abrupt. The B is a dark brown clay with well developed blocky structure and is about 20 inches thick. It overlies a calcareous clay C horizon.

The thickness of the silt loam deposit on top of the clay varies from 0 to 26 inches in areas where the Smithville is mapped. In most instances the silt is 14 inches thick and only on the steep slopes has it been completely removed.

Location and Extent.
Only one soil type, Smithville silt loam, is mapped in the region and it occupies about 1200 acres in one area just north of Port Dover. Other areas of Smithville silt loam are associated with the Haldimand soils occupying the better drained sites close to the streams and rivers. These areas are too small to show on the soil map.

Topography and Drainage.
The topography is gently to steeply rolling with slopes varying from 7 to 30 percent. Surface drainage is good but internal drainage is slow.

Native Vegetation.
The tree vegetation that once covered the Smithville soils is somewhat difficult to reconstruct because most of the soils are cleared. Trees remaining in fence rows and a few woodlots indicate that red, white and black oak, butternut, walnut, hickory, sugar maple and beech were once quite common.

Waterloo Series
Only one soil type occurs in this series — Waterloo fine sandy loam. This soil looks much like the Fox soils but the profile is deeper. The cultivated surface layer is 10 inches thick and underlain by a fine brown sandy loam horizon which becomes pale brown as depth increases. These Ae horizons are underlain by a dark brown loam or clay loam B horizon which rests on gray calcareous fine sands sometimes containing gravel strata. The depth of the profile to the calcareous C horizon may be as great as 60 inches but is more often around 48 inches.

The Ah and Ae layers are often neutral to slightly alkaline but may be slightly acid. The B horizon is neutral to alkaline and the underlying parent material is strongly alkaline and high in lime.

Location and Extent.
This soil occurs along a ridge of land extending diagonally across Windham Township through the villages of Vanessa and Windham Centre and also along the ridge on the west side of Townsend Township near Wilsonville

gure 7-6/Waterloo fine sandy loam is
aracterized by fine sandy materials, a
ngued B horizon and a deep leached layer.

nd Waterford.

opography and Drainage.
ne topography is rolling and the
atural drainage is good.

ative Vegetation.
ost of the tree growth and natural
egetation has been cleared from this
il and it is nearly all under cultivation.
owever, hard maple, oak, hickory and
ne are seen in the few woodlots and
nce-rows left on this soil type.

griculture.
his soil is used mainly for the pro-
uction of cereal grains, grain corn and
rage crops. Some cash crops are
own. A small amount of the land is
ed for tobacco; tree fruits are grown
well as a comparatively small acreage
canning crops. Almost all the ginseng
own in Canada is grown on the
aterloo soil in Norfolk County.

auseon Series
e Wauseon soil is poorly drained
d developed on shallow deposits of
twash sandy loam and loamy sand
er a heavier substratum of clay
d silt.

The cultivated surface soil is a very
rk gray or black sandy loam with a high organic matter content. The second layer is a gray loose sandy loam or loamy sand, with yellow and reddish brown splotches which increase with depth. A gray brown sandy clay or clay substratum lies at depth ranging from 1 to 2 feet.

The reaction is neutral to alkaline and the upper sandy layers are stonefree.

The Wauseon differs from the Granby in having the clayey substratum close to the surface.

Location and Extent.
The main area of Wauseon soil in Haldimand County extends from Dunnville northeastward to the Welland County boundary, the greater proportion being in the township of Moulton. Although the Wauseon is not shown in Norfolk County it sometimes occurs as an inclusion in areas called Watrin.

Topography and Drainage.
The topography is almost level. The undulations common to the Berrien area are rare in this type. The natural drainage is poor on account of the absence of slope and because of the imperviousness of the subsoil.

Native Vegetation.
The common forest trees occurring on this type are elm, soft maple, ash, birch and plane tree. The latter is the most common and practically the only representative of the flora which characterizes the Niagara Deciduous Forest Region to which Haldimand County climatically belongs.

Agriculture.
Only a moderate proportion of the land has been cleared. It is fairly well adapted to the production of hay, pasture and to a lesser extent, grain. In the Dunnville district it has been used in the production of tomatoes and other canning crops but only when drained. Woodlots are quite common on this type.

The potential fertility of this type is about medium. The organic matter content is about medium and the reaction is about neutral. The levels of available phosphate are low; potash, calcium and magnesium medium to low.

Soil Complexes
There are occasions when two or more soil series occur in more or less the same proportion and change from one series to another over very short distances. Under such conditions the delineation of the soils is impossible except when maps of very small scale are used. When this situation occurs on maps of the scale accompanying this report soil complexes are mapped.

In Haldimand-Norfolk there are two complexes both of which are found in Norfolk County.

Fox-Granby
The Fox-Granby soil complex occurs where there is a micro-relief of knolls and hollows. Fox soils occupy the knolls and Granby the hollows. Imperfectly drained Brady soils occupy the transition zone between the well drained Fox and poorly drained Granby. Distances are so short from knoll to depression that no one soil condition can be managed separately except under conditions of intensive use as would be expected for the home flower or vegetable garden.

Brief profile descriptions of the Fox and Granby soils have been given. Brady soils resemble the Fox except that the Ae and B horizons are mottled and the B horizon has a duller color in the Brady than in the Fox. In some instances the extra moisture in the Brady soils is an advantage since water is often available during dry periods. On the other hand the high organic matter content that often accompanies moist conditions is sometimes a detriment to tobacco production.

This complex was called Watrin sand on the original soil map. It occupies 49,000 acres in Norfolk County and was not mapped in Haldimand.

Colwood-Muck
There are two large areas of the Colwood-Muck complex, one east of Simcoe and one west of Waterford. In total there are 10,000 acres of the complex occurring in Townsend, Windham and Woodhouse Townships. In general the muck is about 2 feet thick and does not lend itself to development for vegetable growing. Indeed little development has gone on in any of the soil

complex probably because it is wet almost all year and the costs of drainage are high. Use for any purpose of the Colwood-Muck complex requires the installation of drains and the provision of outlets.

Interpretive Soil Classification

In the following pages the soils data both on the map and in the report have been interpreted for various uses. This information is intended to assist in the planning process by indicating some of the limitations and advantages of a specific site for various uses. Some of the material presented in map form (Maps 2 to 6) is self-explanatory and no further discussion is required. Other map information needs expansion.

The following analysis is given to clarify and describe some of the relationships between soils and such uses as agriculture, urbanization and recreation. No matter what the use there are times when excessive manipulation of soil is needed before a specific use can be effected. Often such manipulation results in high costs and losses in environmental quality that would have been better avoided. It is expected, therefore, that the following information will be of some assistance in selecting land use alternatives, and perhaps reduce conflict.

Soil Capability for Agriculture

This is one of many interpretations that can be made from soil survey information. The soils are grouped into seven classes according to their potential for the production of general farm crops. Class 1 is best and Class 7 is poorest. Classes 2 to 7 inclusive may be subclassified. The definitions of the classes and subclasses along with other information which will assist the reader in the use of the soil capability map are given in Appendix C. The acreages of the classes and subclasses of land are shown for each township in Table 7-1.

Table 7-1/Soil Capability Acreages.

Classes / Townships	1	2	3	4	5	6	7	Organic (O)	Totals
Norfolk									
Houghton	—	3,070	—	11,675	11,800	7,780	—	—	34,325
S. Walsingham	—	15,360	—	10,445	5,115	6,965	16,385	—	54,270
N. Walsingham	2,765	—	1,845	21,610	4,610	11,160	—	—	41,990
Middleton	1,535	5,885	1,025	16,845	13,380	4,915	—	1,280	44,860
Charlotteville	2,300	8,705	1,540	23,295	11,010	13,825	2,815	—	63,490
Windham	4,145	13,825	2,765	27,065	14,335	3,070	—	1,025	66,230
Woodhouse	1,230	28,415	820	2,965	1,270	615	—	255	35,570
Townsend	4,300	49,660	2,870	7,070	510	100	—	510	65,020
Totals	16,275	124,920	10,865	120,970	62,030	48,430	19,200	3,070	405,760
Haldimand									
Walpole	5,940	60,420	3,020	—	770	2,050	—	—	72,200
Rainham	—	26,365	255	—	510	—	255	—	27,385
S. Cayuga	460	14,335	565	—	770	510	—	—	16,640
N. Cayuga	7,985	14,585	7,630	—	1,535	1,025	—	—	32,760
Oneida	17,665	8,960	15,360	—	1,280	2,050	—	—	45,315
Seneca	7,985	29,180	5,325	—	1,280	—	—	—	43,770
Canborough	—	19,970	—	1,280	770	—	—	—	22,020
Dunn	770	13,055	1,020	—	2,050	255	255	—	17,400
Moulton	—	19,195	—	11,775	4,345	—	—	510	35,825
Totals	40,805	206,065	33,175	13,055	13,310	5,890	510	510	313,320

Soil Capability for Recreation

Table 7-2/Soil Capability for Recreation

Soil and Site Factors	Subclass Symbol	Capability Classes 1	2	3	4	5
Landscape — slope	L	3-30%	3-30%	30%	0-2%	0-2%
— variability		high	moderate	high-mod.	low	low
Drainage	W	good	moderate	rapid	poor	very poor
Fertility	F	high-med.	high-med.	low	high-low	high-low
Texture	A	loams silt loams	sandy loams silty clay loams clay loams	loamy sands gravels fine sandy loams clays	silts very fine sands	all textures of wet locations
Stoniness	P	classes 0, 1	classes 0, 1	class 2	class 3	class 4
Flooding	I	none	occasional (10 wks.)	frequent (6-10 wks.)	very frequent (3-5 wks.)	very frequent (2 wks.)
Impermeable layers	Y	none	one or more 3 ft. deep	one or more 2-3 ft. deep	one or more 1-2 ft. deep	one or more 1 ft. deep
Depth to bedrock	R	5 ft.	5 ft.	5 ft.	5 ft.	5 ft.

The usefulness of soil survey data in the mapping of capability for recreation may be questioned. It is true that recreation capability is not closely related to soils, and rarely is soil the critical factor. The exception is the presence of sand water's edge. An excellent natural beach can often be predicted accurately from a soil map.

In various other instances soil factors exert a more or less strong influence on recreation capability. Limiting examples include: severe boulder conditions in the surface soil, stony till shore lands, impermeable hard pan layers or other natural drainage restrictions, shallow soil over bedrock, surface erosion hazards and susceptibility to flooding. The likelihood of potable subsurface water is often known to the soils man, and the recreation quality of streams and small lakes can be predicted from surrounding soils.

Much more valuable than the information the recreation man can interpret from the soils map is the familiarity of the soil scientist with much of the landscape the former is mapping. Additionally, soils people have taken note of many of the natural and cultural objects of the landscape; this familiarity can save the recreation capability assessor many miles of travel and hours of inquiry and interpretation. Every soil scientist is something of a geomorphologist, and there is a close relationship between land form and recreation capability. Needless to say, the soil map which shows contours is much more useful than that which does not.

The system used here for the classification of sites for recreation is quite unlike the Agricultural Rehabilitation and Development Administration system. First of all, and probably most important, this system is concerned only with the soil and the influence of recreation upon it. In other words, this system endeavours to point out the limitations of the soil to recreational uses rather than the feature attractions available to the user as the ARDA system does. This basic difference plus the fact that this is a five-class system (ARDA's is 7) make for some differences in classification of the same site. For example, the Eastport sand because of its location along the Lake Erie shore provides an excellent beach and as such would be Class 1 in the ARDA system. The soil capability system rates it Class 3, however, because of droughtiness, coarse texture and low fertility. These limitations would curtail its usefulness for all but water-based activities.

The soil capability system used in this study is not intended to replace the ARDA system. It is merely added information which can be used to evaluate such things as trafficability, erosion potential, compaction and flooding hazard for areas used for recreation. This system is based upon fairly intensive recreation activities. It is possible that soils related in the lowest classes could have a high visual appeal and interpretive quality. This is particularly true of the waterlogged soils which may produce an interesting plant community. The numbers of people viewing this may be restricted, however, because of the high water table which exists most of the year.

The soil and site factors used to estimate soil capability for recreation are shown in Table 7-2.

Class 1 Soils

Brant loam 0-5% slopes[1]
Brant loam 6-12% slopes[1]
Brant silt loam 0-5% slopes
Brant silt loam 6-12% slopes
Ontario loam 0-5% slopes
Ontario loam 6-12% slopes
Smithville silt loam 0-5% slopes
Smithville silt loam 6-12% slopes

These are soils which have little or no limitation for use in recreational pursuits. They can withstand heavy traffic, do not compact readily and yet have sufficient fertility and moisture that they

can support a dense cover of grasses and clovers. As a result they can be used for such outdoor activities as hiking, camping, and picnicking, along with associated sports without need for costly conservation measures. In addition the slopes are smooth enough so that playing fields can be readily provided but are sufficiently varied that an interesting view is present.

Class 2 Soils
Fox sandy loam
Huron clay loam 0-5% slopes
Huron clay loam 6-12% slopes
Onondaga clay loam 0-5% slopes
Onondaga clay loam 6-12% slopes
Perth clay loam

These soils have some hazard which limits their use for recreation. Texture is a limiting factor in all. The Fox sandy loam dries out quickly after a rain but is often droughty and will not produce a lasting, dense cover. The clay content of the clay loams is high enough that compaction occurs under intensive use. Compaction retards water movement and root penetration, thus increasing the chances of cover crop loss and subsequent erosion. Perth clay loam is imperfectly drained and is, therefore, an unreliable site for certain activities at some times of the year.

Class 3 Soils
Bottom land
Eastport sand
Fox fine sandy loam
Fox coarse sand
Haldimand clay
Plainfield sand 0-5% slopes
Waterloo fine sandy loam 0-5% slopes
Waterloo fine sandy loam 6-12% slopes
Waterloo fine sandy loam 13-20% slopes

These soils are placed in Class 3 for recreation because they have a sandy texture which blows away easily when the vegetative cover is thin or a clay texture which compacts readily, or they are flooded for a part of the year. The fine sandy loams are very susceptible to wind erosion and blowouts are common in some places. Bottom land floods at least once a year, usually in the spring, but much of the bottom land in the Haldimand-Norfolk region is found in the Grand River basin where water control installations have much reduced the danger of flooding.

Class 4 Soils
Berrien sandy loam
Brookston clay
Colwood loam
Gilford loam
Granby sandy loam
Jeddo clay
Plainfield sand 6-12% slopes

The Brookston, Colwood, Gilford, Granby and Jeddo soils are poorly drained and are therefore saturated at least 10 months of the year unless artificially drained. Berrien sandy loam is also saturated part of the year but not for so long a period as the other soils. This does limit the use of the soil but the presence of relatively impermeable clay layers at 2 or 3 feet also present a hazard to use by making the installation of a drainage system more difficult.

Plainfield sand with 6 to 12 percent slopes erodes easily. In general the sand is fine, has a low fertility and, once the trees are removed, blows away.

Class 5 Soils
Caistor clay loam
Caistor loam
Farmington loam
Muck
Wauseon sandy loam

These are the soils that present the greatest hazards to recreational uses. A compact B layer with a high clay content and poor soil structure make the Caistor soils hazardous to use except under special circumstances. Farmington loam is shallow over bedrock and during periods of heavy rainfall becomes saturated quickly and floods. It also dries rapidly and has a low moisture reserve, causing plants to die of drought. Both Muck and Wauseon soils are very wet and therefore only of use when the water table falls in August.

Capability Classification for Waste Disposal

Soil and Site Factors
In Table 7-4, a scheme is presented for classifying soils as to their suitability for the disposal of household waste mainly septic tank effluents. The more important features describing "soil and site factors" are detailed as follows.

Depth to bedrock.
Bedrock near the soil surface effectively limits the volume of soil available for disposal purposes. Dense rock acts as an impermeable barrier with the result that the shallow soils become waterlogged and foul odors develop. Porous or highly fissured bedrock permits the raw effluent to flow almost directly to groundwater, shallow wells, or to bodies of surface water at lower elevations.

Depth to watertable.
Most health authorities specify 4 to 5 feet of soil over bedrock or that depth to the water table. As used in this description "depth to water table" is that elevation at which water will appear in a hole dug for observing soil properties and drainage conditions. Soils in which the water table is less than 5 feet from the surface are wholly unsuitable as a medium for waste disposal. In wet poorly drained soils, anaerobic conditions are known to exist with the result that vegetation will not absorb significant quantities of waste products, denitrification occurs, and phosphates are not degraded biologically or absorbed by soil particles.

Slope and seepage.
Soil slope determines the pattern in which the effluents are distributed. On slopes greater than 4 to 6 percent, tile lines must be laid on the contour to facilitate uniform distribution of the effluent. As the slope increases about 6 percent, greater care is required in trenching, laying tiles, and in making proper connections for uniform distribution of the effluent. Naturally occurring seepage areas and flowing springs are most likely to occur on sloping land. Such sites are unsuitable for either dumps or weeping tile beds.

Stoniness and trees.
Installation costs increase rapidly as th

able 7-3/Soil Capability for Waste Disposal.

oil and Site Factors	Subclass Symbol	Capability Classes 1	2	3	4	5
epth to bedrock	R	5 ft.	5 ft.	5 ft.	5 ft.	5 ft.
epth to watertable	B	5 ft.	5 ft.	3 ft. - 5 ft.	4 ft.	3 ft.
lope — percent pattern	T	0 to 2% Aa	3 to 6% B	3 to 6%-b 7-12%-C	7 to 12%-c	12%
toniness	P	classes 0, 1	classes 0, 1	class 2	class 3	class 4
atural drainage	W	good	moderate	imperfect	poor	very poor
exture	A	loams clay loams	fine sandy loams sandy loams clays	loamy sands gravels silt loams	very fine sands silts organics	any texture with high water table
tructure	D	strongly granular or blocky; porous; water stable	moderately strong granular or blocky; porous; water stable	weakly granular	structureless unstable	structureless
npermeable layers	Y	none	one or more 3 ft. deep	one or more 2-3 ft. deep	one or more 1-2 ft. deep	one or more 1 ft. deep

olume of "soil" occupied by stones nd boulders greater than 4 inches in iameter increases. The greater cost is ssociated with the trenching and the roper laying of individual tiles. Trees nd weeping tile beds are incompatible n the same plot of land. Unless the ees are removed, the roots will pene- ate and plug the drain. Trees also terfere with other means of waste sposal and must be removed in areas be used for sanitary landfill.

atural soil drainage.
a soil is examined under natural nditions in the field, the experienced assifier readily identifies morpho- gical features in the profile related to e natural drainage. Soils that are oorly drained most of the year have a naracteristic drab, dull, grey layer mediately under the high organic rface. Periodic flooding or short riods of high water table are reflected blotches or deposits of reddish, llowish and brownish oxides of iron. the natural drainage of a soil be- mes progressively poorer the degree waste treatment and renovation is so lowered. Adequate waste treatment ing a soil as a disposal medium quires aerobic conditions.

oil texture.
oil texture refers to the percentage mposition of the mineral fraction of a soil in terms of sand, silt, and clay. Classes range from coarse gravelly materials to impermeable fine clays. A soil may be so permeable that effluents are not filtered and the residence time is too short for biodegradation. In impermeable soils, the effluents are retained at or near the surface and develop foul smelling odors. The better soils for sewage disposal beds are intermediate in texture — loams, most silt loams and clay loams. They present a relatively large surface area (due to the clay content) for absorption sites and retain the effluents long enough to facilitate biological activity. Several kinds of soil present serious problems in permeability especially if they occur as lenses or segregated layers in a soil that is otherwise acceptable. Particular attention should be paid to very fine sands and silts; the individual particles are so arranged as to form a very slowly permeable layer.

Soil structure.
Structure refers to the arrangement of sand, silt, clay to form natural aggregates or structural units. A highly desirable type of structure is that found under grasses that have been established for several years. A good porous structure is usually associated with the organic matter in the surface layer. A porous structure (sands and gravels are structureless) permits water to flow and air to enter the soil to enhance biological activity. Weeping tiles frequently become clogged when a poor soil structure impedes good drainage; the soil pores are filled with solids from the effluent; or the structural units are disintegrated by the dispersing action of detergents. Drain clogging is most frequent under anaerobic conditions and has been related to biological activity and the chemical precipitation of insoluble compounds such as ferrous sulphide and ferrous phosphates.

The soil and site factors affecting waste disposal and their use in establishing capability class are shown in Table 7-3. The soils of the region may be listed by class as follows.

Class 1 Soils for Waste Disposal
Brant loam 0-5% slopes
Brant silt loam 0-5% slopes
Fox fine sandy loam
Huron clay loam 0-5% slopes
Ontario loam 0-5% slopes

These are the soils that provide the best media for waste disposal in Haldimand-Norfolk.

Class 2 Soils for Waste Disposal
Fox sandy loam
Onondaga clay loam 0-5% slopes
Waterloo fine sandy loam 0-5% slopes

These soils have some limitation which

requires attention before they can be used for waste disposal purposes. Both the Fox sandy loam and Waterloo fine sandy loam have coarse textures which permit rapid infiltration of solutions and subsequent danger of pollution of nearby open water. The Onondaga is not nearly so permeable, and moisture tends to run off the soil rather than through it thus creating a pollution hazard.

Class 3 Soils for Waste Disposal
Berrien sandy loam
Brant loam 6-12% slopes
Brant silt loam 6-12%
Caistor clay loam
Caistor loam
Fox coarse sand
Haldimand clay
Huron clay loam 6-12% slopes
Onondaga clay loam 6-12% slopes
Ontario loam 6-12% slopes
Perth clay loam
Plainfield sand 0-5% slopes
Smithville silt loam 0-5% slopes
Waterloo fine sandy loam 6-12% slopes

This group of soils can be considered as fair for waste disposal. All have specific limitations which can be overcome but with more difficulty than those of the soils in Class 2. Some of the above soils are in Class 3 because their topography is a little too rolling. Others, like the Berrien sandy loam have impermeable layers at less than 3 feet and these are overlain by permeable sands. The Caistor, Haldimand and Perth soils are imperfectly drained and the Smithville has too high a silt content to be especially good for below ground installations although it may be suitable for waste material spread on its surface. Some of the soils — Fox coarse sand, Plainfield sand and Waterloo fine sandy loam — are very permeable; the Waterloo has the additional problem of rolling slopes.

Class 4 Soils for Waste Disposal
Brookston clay
Colwood loam
Eastport sand
Jeddo clay
Plainfield sand 6-12% slopes
Smithville silt loam 6-12% slopes

Brookston clay, Colwood loam and Jeddo clay are poorly drained and the fact that they are saturated for 10 months of the year renders them unsatisfactory for many types of waste disposal. Eastport sand is very coarse, has little or no water-holding capacity, and is not a particularly good waste disposal medium. Similarly Plainfield sand is coarse but in addition this particular Plainfield has rather rolling slopes. Rolling topography and silty texture make the Smithville a low choice for septic tank installation.

Class 5 Soils for Waste Disposal
Farmington loam
Gilford loam
Granby sandy loam
Muck
Waterloo fine sandy loam 13-20% slopes

These soils are in Class 5 because they are very wet (Gilford, Granby and Muck), shallow over bedrock (Farmington), or very steep (Waterloo fine sandy loam 13-20% slopes). Each soil has hazards that are difficult and costly to overcome. Their use for waste disposal purposes would be most unwise.

One soil in the region is completely unusable for waste disposal. This is the bottomland. Periodic flooding makes it totally unsuitable.

The soil capability for urbanization is nothing more than an attempt to indicate which soil characteristics are most likely to have an effect on a site selected for both the "in-soil" and "on-soil" forms of construction. Such things as buildings, roads, pipelines an landscaping are all affected by certain features of the soil. These are listed in Table 7-4.

Capability Factors

Depth to bedrock.
Obviously areas with little or no soil cover are going to present certain difficulties to the construction of certain below-ground facilities. Also shallow sites present a serious limitation to house construction. In general basements cannot be built without addition expense and those that are placed below grade may prove to be wet due to the transverse movement of water.

Depth to watertable.
Soils with a high watertable are unsuitable for below-grade construction unless means can be devised to install drainage.

Slope.
Both slope and its pattern can affect th cost or difficulty of construction. Soils with steep slopes require cut-and-fill techniques or levelling for many types of construction. The slope pattern is also important. Smooth slopes (identified by capital letters) are much easier to manage than those that are complex or irregular (identified by lower case letters). Slopes and their patterns are as follows:

Smooth	*Percent Slope*	*Irregu*
A	0 — 2	
B	3 — 6	
C	7 — 12	
D	13 — 20	
E	21 — 30	
F	31 +	

Stoniness.
This is a limitation mainly when stones are present in large numbers. Althoug stones are not present in overwhelming numbers in the soils of the

able 7-4/Soil Capability for Urbanization.

oil and Site actors	Subclass Symbol	Capability Classes 1	2	3	4	5
epth to bedrock	R	20 ft.	8-20 ft.	0-8 ft.	0-8 ft.	0-8 ft.
epth to watertable	B	20 ft.	20 ft.	8-20 ft.	0-8 ft.	0-8 ft.
lope — percent	T	0-6%	7-12%	7-12%-c	13-20%-d	20%
pattern		Aa, Bb		13-20%-D		
toniness	P	classes 0, 1	classes 0, 1	class 2	class 3	class 4
latural drainage	W	good	moderate	imperfect	poor	very poor
exture	A	loams clay loams	fine sandy loams sandy loams clays	loamy sands gravels silt loams	silts very fine sands organics	any texture with high water table
tructure	D	strong granular blocky; porous; water stable	moderately strong granular or blocky	weak granular or blocky; porous; water stable	structureless unstable	structureless
npermeable layers	Y	none	one or more 3 ft. deep	one or more 2-3 ft. deep	one or more 1-2 ft. deep	one or more 1 ft. deep

aldimand-Norfolk region a brief escription of stoniness follows should is classification be required for her areas.

toniness lass	*Description*
	stonefree
	few stones
	moderately stony — enough to interfere with trenching, digging, etc.
	very stony — enough to seriously interfere with trenching, digging, etc.
	exceedingly stony — stones so numerous that they often touch one another; trenching, digging etc. extremely difficult; serious problem of stone disposal created.

ainage.
oils that remain saturated for most of e year (10 to 11 months) are said to be orly drained. Similarly soils saturated r eight months or so are imperfectly ained. Such conditions affect road nstruction and building construction ich is likely to be disturbed by con- ions of high moisture.

xture.
rtain sizes of soil particles provide a better base for construction than others. Silt-size particles erode easily and soils with a high silt content slip and slide unless carefully managed. Slopes must never be steep along roadsides nor should the soil be exposed to wind and water for long periods of time. Gravels are aquifers and often contain lenses of quicksand which can add to the costs of building if not identified and located. Organic soils subside; clays should not be disturbed when wet; and loamy sands have a low fertility. All of these have an effect on the quality of the soil as a site for urbanization and once the limitations of texture are recognized steps can be taken to avoid making costly errors.

Structure.
The ideal soil must, among other things, have a well developed water-stable structure. Structure does not seriously affect most construction pursuits but it does influence the ease with which landscaping can be conducted. Unstable clays and structureless sands do not provide a very good medium for plant growth and they require very careful handling when used for plant production.

Impermeable Layers.
Impermeable layers in the soil interfere with soil moisture and root penetration. These, like structure, have some influence on the landscaping of an area and also may interfere, to some extent, with installation of drainage tile, pipelines and other underground installations.

Class 1 Soils for Urbanization
Brant loam 0-5% slopes
Huron clay loam 0-5% slopes
Onondaga clay loam 0-5% slopes
Ontario loam 0-5% slopes

These are the best soils in the region for below-ground and on-ground types of construction. They require little or no reclamation procedures to make them suitable sites for building, roads, pipelines, etc.

Class 2 Soils for Urbanization
Brant loam 6-12% slopes
Fox fine sandy loam
Fox sandy loam
Onondaga clay loam 6-12% slopes
Ontario loam 6-12% slopes
Plainfield sand 0-5% slopes
Waterloo fine sandy loam 0-5% slopes
These soils have only moderate limitations when used for urbanization. The Fox, Plainfield and Waterloo — being sandy soils — are droughty, susceptible to wind erosion and have a low fertility. The fine sandy loams are particularly erosive and should be kept under a grass cover as much as possible. The slopes on the Brant, Onondaga and

Ontario soils sometimes require levelling before they can be used as building sites. In addition the installation of roads and certain underground services may be more costly than on level soils.

Class 3 Soils for Urbanization
Berrien sandy loam
Brant silt loam 0-5% slopes
Brant silt loam 6-12% slopes
Caistor clay loam
Caistor loam
Fox coarse sand
Haldimand clay
Huron clay loam 6-12% slopes
Perth clay loam
Plainfield sand 6-12% slopes
Smithville silt loam 0-5% slopes
Waterloo fine sandy loam 6-12% slopes

Rolling topography increases the cost of urbanization on the Waterloo, Plainfield, Huron and Brant soils in the above list. High clay content, poor structure and a period of saturation that lasts for seven or eight months place moderately severe limitations on the use of Caistor, Haldimand and Perth soils for building purposes. The Berrien sandy loam is not only saturated seven months of the year, it also consists of 2 or 3 feet of sand on clay which causes lateral movement of water and may result in wet basements. The Brant and Smithville soils are highly susceptible to erosion due to their high silt content and must be handled with care. The Fox coarse sand is very dry, requires constant irrigation during most of the growing season and will be a source of constant irritation to the inexperienced gardener.

Class 4 Soils for Urbanization
Brookston clay
Colwood loam
Eastport sand
Jeddo clay
Smithville silt loam 6-12% slopes
Wauseon sandy loam
Waterloo fine sandy loam 13-20% slopes

Brookston clay, Colwood loam, Jeddo clay and Wauseon sandy loam are all wet soils. They are saturated for at least 10 months of the year and the water table is at or very close to the surface for much of this period. Tiling and the provision of adequate outlets are a must before any kind of construction can take place.

Eastport sand is seldom used for construction purposes. Its very nature and its location along the lakeshore make it suitable only for cottages. Both the rolling Smithville and Waterloo soils are highly susceptible to erosion. Great care should be taken to keep the slopes of roadside banks and cuts as long as possible. It is suggested that these slopes never exceed 10 percent. Steeper slopes soon undercut, slump and wash away.

Class 5 Soils for Urbanization
Farmington loam
Gilford loam
Granby sandy loam
Muck

The Farmington loam provides a strong foundation for building but, because the bedrock is at or near the surface, presents all sorts of limitations. Flooding often occurs during sudden heavy rainfalls and only those projects requiring a minimum of excavation can be profitably undertaken. Both Gilford and Granby soils are wet. In addition they are aquifers with a water table that seldom drops below 8 feet. Much of the year, water lies on the surface and drainage is difficult because of the depressional nature of the topography. Muck is also very wet and standing water is common. When muck is drained it subsides causing cracked walls and joints and considerable havoc in any building sited on it.

A summary of soil capability for agriculture, recreation, waste disposal and urbanization is presented in Table 7-5. Some rather interesting conclusions concerning the soils of the region can be gained from this table. Wetness or drainage is a greater limiting factor to recreation, waste disposal and urbanization than to agriculture. It is not that a systematic system of tile drainage is more difficult to install for uses other than agriculture. Rather, a more sophisticated system is often needed and yearly upkeep is more costly.

Low fertility is a limitation on the sandy soils and mainly affects agricultural uses. Agriculturalists are concerned with crop production and must obtain high yields of quality food materials if they are to stay in business. Maintaining the fertility of the soil is important to them and this is a problem on coarse-textured soils. On the other hand, fertility is not of sufficient consequence to limit other uses although it may be of concern to the householder trying to grow a lawn or a garden.

Two terms have been used which refer to the lay of the land. One, *landscape,* refers to the percent slope and the variability of the landscape. The other, *topography,* deals with the percent slope and the regularity of the slopes. The term *landscape* has been used only in the soil capability classification for recreation. Here, rolling slopes do not present the problem they do for other uses. Instead, large flat surfaces are a limitation because they lack variability and hence have little interest to the viewer. The term *topography* has been used in all the other classifications because steep, complex slopes are a limitation to agriculture, septic tank installations and urbanization.

Flooding occurs in the bottomland along the stream courses and limits the use of these lands to uses which require no permanent installations of any type. For obvious reason the floodplains can not be used for waste disposal or urbanization but they can be used for certain recreational pursuits and for the production of some crops especially

ermanent pasture.

Three soils are Class 1 for all uses nentioned. These are Ontario loam)-5% slopes, Brantford clay loam 0-5% lopes, and Brant loam 0-5% slopes. here are other soils, Huron clay loam)-5% slopes, Brant silt loam 0-5% lopes and Onondaga clay loam 0-5% lopes, which, except for minor limitaions for one use or another, are also onsidered to be of high quality. The oorest soils for agriculture, recreation, vaste disposal and urbanization are he very wet soils, the shallow soils, the ery dry sands and the organic soils. hese include such soil types as bottom and, Eastport sand, Farmington loam, ilford loam, Granby sandy loam, Muck, lainfield sand 6 to 12 percent slopes nd Wauseon sandy loam. It is these oor soils that are the most difficult to lan. Reclamation may be so costly for ost uses that no profits can be alized. Such soils are probably best ft in their natural state to preserve balanced ecology or used for some ss intensive purpose such as hiking or iewing.

Table 7-5/Summary of Soil Capability for Agriculture, Recreation, Waste Disposal and Urbanization.

Soil Type	Class and Subclass for Agriculture	Class for Recreation	Class for Waste Disposal	Class for Urbanization
Berrien sandy loam	2F	4^{L}_{Y}	3^{Y}_{B}	3^{W}_{Y}
Bottom land	5I	3I	unusable	unusable
Brookston clay	2W	4^{W}_{A}	4^{W}_{A}	4^{W}_{D}
Brant loam 0-5%	1	1	1	1
Brant loam 6-12%	3T	1	3T	2T
Brant silt loam 0-5%	1	1	1	3A
Brant silt loam 6-12%	3T	1	3T	3^{A}_{T}
Brantford clay loam 0-5%	1	1	1	1A
Brantford clay loam 6-12%	3T	1	3T	3T
Caistor clay loam	2D	$5^{L}_{D,A}$	3^{A}_{W}	3^{W}_{D}
Caistor loam	2D	$5^{L}_{D,A}$	3^{A}_{W}	3^{W}_{D}
Colwood loam	2W	4W	4W	4W
Eastport sand	7E	3^{W}_{A}	4^{A}_{D}	4D
Farmington loam	6R	5R	5R	5R
Fox fine sandy loam	2^{F}_{M}	3^{L}_{A}	1	2A
Fox sandy loam	2^{M}_{F}	2A	2A	2A
Fox coarse sand	4^{F}_{M}	3^{F}_{A}	3^{A}_{D}	3A
Gilford loam	4W	4^{W}_{L}	5^{W}_{A}	5^{W}_{A}
Granby sandy loam	5W	4^{W}_{L}	$5^{W}_{A,D}$	5^{W}_{A}
Haldimand clay	2D	3A	3^{A}_{W}	3^{W}_{A}
Huron clay loam 0-5%	1	2A	1	1
Huron clay loam 6-12%	3T	2A	3T	3T
Jeddo clay	3^{W}_{D}	4^{W}_{A}	4^{W}_{A}	4^{W}_{A}
Muck	not rated	5^{W}_{I}	5^{W}_{B}	5^{W}_{B}
Onondaga clay loam 0-5%	1	2A	2T	1
Onondaga loam 6-12%	3T	2A	3T	2T

Table 7-5/ (Cont'd.)

Soil Type	Class and Subclass for Agriculture	Class for Recreation	Class for Waste Disposal	Class for Urbanization
Ontario loam 0-5%	1	1	1	1
Ontario loam 6-12%	3^{T}_{P}	1	3T	2T
Perth clay loam	1	2W	3W	3W
Plainfield sand 0-5%	4^{F}_{M}	3^{F}_{A}	3A	2A
Plainfield sand 6-12%	6^{T}_{E}	3^{F}_{A}	4^{A}_{T}	3^{A}_{T}
Smithville silt loam 0-5%	1	1	3A	3A
Smithville silt loam 6-12%	3T	1	4^{A}_{T}	4^{A}_{T}
Wauseon sandy loam	4W	5^{W}_{Y}	$4^{W}_{Y,B}$	$4^{W}_{Y,B}$
Waterloo fine sandy loam 0-5%	2^{F}_{M}	3A	2A	2A
Waterloo fine sandy loam 6-12%	3^{T}_{M}	3A	3^{A}_{T}	3^{A}_{T}
Waterloo fine sandy loam 13-20%	4^{T}_{M}	3A	5^{T}_{A}	4^{T}_{A}

Norfolk, Haldimand and Brant Counties are situated in southwestern Ontario bordering on the eastern half of Lake Erie and south and west of the western tip of Lake Ontario. This location provides a climate which is relatively favorable for the production of fruits, vegetables and field crops which require a relatively long frost-free period. Almost all of the other farming areas in Canada have lower average growing season temperatures and shorter frost-free periods except for the areas in Ontario adjacent to Lake Erie to the west of the project area and a narrow strip of land bordering Lake Ontario to the east.

The project area is also located within the 100-mile radius of Metropolitan Toronto and the adjacent "Golden Horseshoe" of urban and industrial development around Lake Ontario. Thus, the area is close to an urban market of more than 3 million people which is the largest, most concentrated and richest urban market in Canada.

These two factors provide the farmers of the project area with the following two advantages: 1) the climate necessary to grow specialized crops; and 2) a preferred market for agricultural products which are perishable and bulky.

Climate and transportation advantages have been prime factors which have provided all Ontario farmers with incentives to increase production to supply the rapidly expanding urban market developing within the province in the last two decades. The third factor contributing to the economic advantage has been soil productivity. Total physical productivity of the Ontario agricultural industry has increased at an annua growth rate of 3.5 percent per year since about 1950. The total urban marke within Ontario has expanded at about the same rate but total demand for Canadian agricultural products (both fo domestic and export sales) has increased at a rate of under 3 percent. Under these conditions the terms of trade have declined for the agricultural industry as a whole. This worsening of terms of trade forces individual farmers to improve efficiency to maintain

reasonable resource returns and forces producing areas which are marginal because of climate, soils or location into the sub-marginal category. Improved agricultural efficiency has been possible within the last two decades by the application of new technology in the form of purchased inputs to a relatively fixed quantity of land and livestock and a declining quantity of labor. These purchased inputs give the greatest return when applied to the most productive soils and when farm-gate prices are highest.

The worsening of the agricultural terms of trade reinforces the economic advantage of farms with a climatic and location advantage, and further enhances this advantage for an area on whose soils and topography the new technology can be applied with ease. Norfolk and Brant Counties have special soils which reinforce the climate and location advantage, but up to the present time special problems of adoption of new crops and technology have been encountered in Haldimand County.

As farm product prices have declined in Canada relative to the prices of other goods and services it has been more difficult for the medium-sized farm to provide acceptable returns to resources. According to the 1966 Census about 70,000 farms had sales of farm products in 1965 of $2500 or more.[2] The Ontario Farm Income Committee reported that the 1966 farm production could have been produced by about 35,000 well organized farms at a reasonable rate of resource returns. Resource adjustment within agriculture is one of the major problems being faced by the industry and this problem will continue into the foreseeable future. Farmers have adjusted within the last two decades but the above estimates indicate that much more adjustment has to take place before all remaining farms are obtaining reasonable resource returns.

As far as Ontario's agriculture is concerned it was pointed out above that the growth rate of physical productivity has averaged about 3.5 percent per year increase for about two decades. During this period the number of farms declined by about 40,000, farm land declined about 12.5 percent and the farm labor force declined about 50 percent. This adjustment resulted in an intensification of production on the good land areas in southwestern Ontario because the reduction in acreages farmed occurred mostly in northern and eastern Ontario. Between 1951 and 1961 gross sales of agricultural products by economic region increased at 5 to 20 percent above the Ontario average in every region south and west of Toronto.[3] The Georgian Bay region north of Toronto and the central region around Toronto just matched the Ontario growth rate but the eastern and northern Ontario regions were below the Ontario growth rate by 25 and 35 percent respectively. The Haldimand-Norfolk-Brant area is in the Lake Erie region which had an agricultural growth rate about 10 percent greater than the Ontario average. This is one of the favored areas of improving agricultural productivity.

Soils of the Study Area and their Effects on the Agricultural Economy

The foregoing analysis indicates that the Haldimand-Norfolk-Brant area has a location and climate which provide a positive advantage in the resource adjustment facing all farmers. However, soils of the project area are more specialized in their use than most of the other areas within the same economic region. Most of Norfolk County and adjacent areas in Oxford and Brant Counties have light sandy soils which were found in the 1920's to be ideally adapted to the production of flue-cured tobacco. The varieties of tobacco developed at that time were adapted to the soils and climate of this area and tobacco farms replaced the existing low income livestock farms. Production of tobacco quickly reached an intensive level of land use on the sandy soils of Norfolk County. As the tobacco crop expanded rapidly, price problems were encountered when year to year supply fluctuations resulted in highly variable prices. The farmers set up voluntary marketing quotas in an effort to stabilize prices. Eventually these quotas became acreage planting rights and Ontario Marketing Board legislation provided the legal basis which allows a producer board to control the supply of the product grown in Ontario. Since the original acreage rights were applied to the tobacco crop in Ontario new varieties and technology have extended the possible area of production. But the acreage quota program of producers has controlled the rate of expansion throughout the province. In 1968, about half the acreage of flue-cured tobacco was grown in Norfolk County and another 25 percent was grown in the two adjoining Counties of Brant and Oxford.

These acreage quotas stabilize price conditions for tobacco farmers. They also make possible the bargaining for price increases to minimize the effect of the worsening terms of trade which have been the lot of most other farmers in the last few years as supply of agricultural products increased faster than demand. To the extent that these practices have been successful in increasing prices, tobacco farmers have been able to obtain above average net returns for resources employed

Figure 7-7/Level, stonefree, well-drained, high quality land produces high quality pasture for first class cows.

Figure 7-8/Grain corn acreage is increasing in the Study Area. This corn on the Haldimand clay plain had a yield of 94 bushels per acre.

compared to other types of farms. The negative results have been that new technology, which reduces unit costs as the size of the enterprise increases, has not been adopted since quotas are not freely transferable between farms and thus limit the average size of each farm. Quotas have thus tended to increase sharply in value as tobacco farming remained a relatively profitable type of farming compared to other types of farming possible for the area.

Rights may limit the adoption of new technology involving efficiencies associated with increased size of business. Rights also limit the entry of new areas, farms and intensification of land use on existing farms and thus limit efficiency of production. But, up to the present, tobacco rights per farm have been large enough to make tobacco one of the most profitable types of farming in the province.

The demand for and price of tobacco have been buoyant for most of the 1960's in Canada; farmers producing the crop have experienced a stable and rising price. If present health campaigns against cigarettes and a changing political situation in southern Rhodesia (a major export area) reduce demand for Canadian production and if variety and cultural research within Canada succeed in making the crop a commercial success for farmers in other provinces, then the policies of the Ontario Flue-Cured Tobacco Marketing Board may not be able to maintain its members' advantageous position. If this happens, the value of acreage rights will likely decline. At the same time, the size of the tobacco crop grown on each farm may be reduced, in an effort to control supply, to a level where production efficiencies decline so that resource returns from tobacco may become very low. Other crops such as corn and potatoes, fruits and vegetables could be grown on this land but if the tobacco farms were to change to these crops a major adjustment program would have to be undertaken.

Finally, the Study Area includes another specific soil type which provides different problems. Most of Haldimand County is overlain by a very heavy, imperfectly drained clay soil. The soil thus limits crops grown to those tolerant to excess water or those which have a low value so that risk of crop damage is minimized. The climate is suitable for temperate zone fruit and vegetable crops and specialized field crops but so far soil management problems have limited the growing of these crops. Therefore, farmers have grown only crops with relatively low input costs in order to minimize the risk of farming.

At present, Haldimand County supports the opposite type of farming to the intensive high value tobacco crop grown in Norfolk County. Here extensive livestock farming based on roughage-consuming animals predominates because of soil type. A soil management problem has limited farming to a type which is less intensive than would be expected from the climate and location.

Dairy and beef farming are the main types in this county. Hogs and poultry are limited because grain and corn production is limited but hog and poultry production based on purchased feed could increase total per farm productivity to make building and labor resources more efficient.

Dairy farms which have a Grade A fluid milk contract can exploit the location advantage, but this advantage is being minimized in Ontario by a single price pool. The climatic advantage of the area is modified by the soil disadvantage and thus land productivity is below that obtained in other areas of Canada which have more severe climates but fewer problems with soil management.

Sources of Data and Method of Estimating Farm Sales

The data used in this analysis are the 1961 and 1966 Census of Canada reports of land use and livestock numbers by townships. These reports are used to estimate changes in land use and livestock numbers between 1961 and 1966. The tables in the census report for Ontario include only selected crops and selected categories of livestock. Since tobacco, one of the most important crops for this project area, is not reported separately, extra information was obtained from the census division about this crop. Tables 27 and 29 in the 1966 Census of Agriculture for Ontario Catalogue No. 96-607 were used to estimate land use. Land under crops, less acreages of selected crops grown, less tobacco acreage grown was used to estimate other field and cash crops.

For livestock, the total numbers of each type of livestock reported in Table 29 of the 1966 Census were used to estimate numbers. An animal unit factor was applied to each type in order to change numbers to a common unit. The basic unit was a mature milk cow or a horse and all other animals were converted to this unit on the basis of estimated feed requirements. The total animals in the dairy herd were estimated by assuming that each milk cow was associated with .7 of head of young stock. These estimated numbers of dairy animals were deducted from total cattle to obtain numbers of beef animals. The animal unit factor for beef was then used to obtain beef herd animal units.

The second source of data was the Agricultural Division of Statistics Canada estimates of Farm Cash Receipts from Farming Operations in Ontario for 1966. This series provides aggregate off-farm sales data by category and inventory changes for Ontario agriculture. The off-farm sales data excludes farm-to-farm sales and thus can be considered as being the gross farm income obtained by the agricultural sector of the economy.

Adjustments were made to appropriate categories to account for inventory changes and to consider the categories of crops grown and livestock kept established from the census data. The major adjustments were an estimate of cattle and calf sales associated with dairy herds estimated at $100 per milk cow. This was deducted from total cattle and calf sales in order to obtain sales from beef herds. About half the positive inventory change was added to the tobacco crop since this crop is stored and sold during the next calendar year and 1966 was a year of increased production of this crop. The remainder of the inventory change was allocated to the beef and hog herds.

Once the above adjustments were made, estimated farm sales per category of crops and livestock were divided by the appropriate 1966 Ontario acreage or animal units. The resulting figure was an Ontario gross farm income for each of the main types of crops per acre or livestock per unit kept. These standards were then multiplied by the township acres and animal units to provide estimates of total gross farm income by each township in 1966.

The analysis is based on the assumption that an acre of crop grown or an animal kept produces standard gross farm income by townships. Between townships, variation of yields, sale prices per unit and amount sold per unit of production, are all assumed to be minimal in the analysis. Of course, farm-to-farm variation of all the above factors is considerable but when the analysis is on a township basis the above variation may be low enough to make the analysis reasonable. This method of obtaining gross farm income was used rather than taking the census of farm sales for 1965 because of the different year of reporting sales and because the census estimate of farm sales is always considerably below the same estimates of farm cash income for the same year.

Methods of Analysis

Gross Sales

Once the gross farm income for each major category of crops and livestock was obtained for each township, the township was ranked. The major unit of ranking was the gross farm income per acre of farmland in the township.

Townships could also be ranked by gross farm income per commercial farm. An estimate was made of the gross farm income by non-commercial farms in the township. This total was deducted from the estimated gross farm income for the township and the resulting figure divided by the number of commercial farms in the township. Gross farm income per acre and per farm are, of course, only approximate indications of net profits obtained by farmers. Unfortunately, neither the census nor the aggregate estimates of farm costs provide data which can be applied by any reasonable method to the above estimates of gross farm income to estimate net profit. The only possible source of such information — the farm accounting program of the Ontario Farm Account Project — provides no data about tobacco farms, the main type of farming in this area. Statistics Canada net farm income estimates indicate that net income was about 30 percent of gross farm income. The 1966 specialized large cash crop, and dairy and beef cattle farms averaged over 25 percent of gross farm income as net income, while specialized feeder hog, poultry and feeder steer farms averaged less than 15 percent of gross farm income as net farm income. Therefore, by using gross farm income to indicate the profitability of agriculture this analysis may be biased against the actual situation if farms in a township have low gross sales or if the predominant type of farm is beef feeder, hog feeder or poultry.

Land Use and Livestock Intensity

The township data were also analyzed to indicate percentage of land planted to tobacco and the livestock units per acre. In Norfolk and Brant Counties some townships had up to 20 percent of the land planted to tobacco and the gross farm income was positively correlated with this percentage figure. Feed grain acreage was correlated with hogs and poultry but the variation in acreage planted to these crops depended also upon numbers of dairy cattle, beef feeder cattle and acreage in tobacco since rye is used as a rotation crop with tobacco. Also, roughage acres were correlated with cattle, horses and sheep numbers. This is the most extensive use of the land and gives the lowest gross farm income per acre. The two are quite closely correlated in the analysis of the townships.

Shift Analysis

The changes in livestock numbers and land use between 1961 and 1966 were also used to analyze township data. Here a modified shift analysis used to analyze changes.[4] The technique used compares actual changes of a group of related crops or livestock in a township with expected changes if growth or reduction of crop areas or livestock numbers had been the same in the township as in the area.

Expected changes are those within a township estimated by applying the area percentage change to numbers occurring in 1961. The area percentage change used in this analysis was the area change occurring between 1961 and 1966 in the 12 southern Ontario counties.[5] The actual change reported was the change occurring within the township between 1961 and 1966 of the related crop or livestock expressed as a percentage of the 1961 numbers. The shift as compared to area change was the difference between the area change and the township changes after the township changes were adjusted for different numbers of each type of crop or livestock on hand in 1961 and is called in the analysis the shift change.

A positive actual change indicated the percentage increase occurring in the 1961-66 period and a negative actual change indicated the percentage decrease. A positive shift change indicated either a weighted percentage increase greater than the area change or a weighted percentage decrease less than the area change. On the other hand, a negative shift change indicated a weighted percentage increase less than the area change or a weighted percentage decrease greater than the area change. Thus, the *actual change* indicated the percentage change, plus or minus, in the township; the *shift change* indicated whether this percentage change was greater or less than could have been expected for area changes.

Table 7-6/Gross Farm Income 1966, Land Use and Livestock Numbers and 1961-66 Changes Townships with Highest Value Added.

County/Township		Brant/Oakland		Norfolk/N. Walsingham		Norfolk/Charlotteville	
Commercial Farms	No.	84		285		314	
Total Acreage	Ac.	8,470		39,234		42,255	
Value Added 1966							
—per acre	$	276		274		266	
—per commercial farm	$	27,200		37,600		35,600	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		1,235	15	8,100	21	8,565	20
Grains and cash crops		3,643	43	12,946	33	12,784	31
Improved pastures and roughages		1,272	15	2,450	6	2,894	7
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		387		502		659	
—per commercial farm		4.6		1.8		2.1	
Cattle, horses and sheep		512		872		872	
—per commercial farm		6.1		3.1		2.8	
		Acres		Acres		Acres	
Acres of feed grain/animal unit — hogs and poultry		7.4		9.9		8.0	
Acres of roughage/animal unit — cattle, horses and sheep		2.5		3.3		3.3	
1961-66 Changes		%		%		%	
Acres feed grain and cash crops							
—Actual		+11		+33		+27	
—Shift		+ 4		+12		+18	
Animal units — Hogs and poultry							
—Actual		+38		− 3		+27	
—Shift		+18		−20		+ 9	
Animal units — Cattle, horses and sheep							
—Actual		−39		+ 2		−24	
—Shift		−32		+ 2		−22	

Analysis of Townships

On the basis of the data available and the types of analyses, the townships in the Study Area have been grouped according to gross farm income per acre. The first group are those with more than $240 gross farm income per acre of farmland. Table 7-6 provides information about the six townships in this group. These included four central and western Norfolk County townships and two southwestern Brant County townships. Gross farm income per farm was also very high averaging between $27,200 and $37,000 per farm.

These estimates indicate that farming in these townships produced sales per acre and per farm considerably above Ontario averages. If net income was in fact about 25 percent or more of the gross value added then net income per farm was above $7000 in these townships in 1966. Tobacco was the main enterprise contributing to this high estimate of gross value added. The crop was grown on 12 to 20 percent of the total farmland in the townships. Roughages were not important being grown on 20 percent or less of the total land. Livestock numbers were quite low per farm averaging less than ten units per farm except in Burford Township of Brant County. The changes indicated that in all of these townships, which in 1966 had above average returns per acre, dependence upon cash crops during the 1961-66 period was increasing. Cattle were either declining in importance or holding steady, while hogs and poultry were increasing in importance in 3 of the 6 townships. Thus, this analysis indicated that agriculture was intensifying in these townships which already had high levels of income per acre since cash crops, hogs and poultry are the more intensive enterprises.

Table 7-7 lists the information on three Norfolk County townships which averaged between $200 and $240 gross sales per acre in 1966. These include the rest of the county except for Woodhouse, the most easterly township in Norfolk County. Tobacco acreage was lower in these townships than in the four Norfolk townships listed in Table 7-6. Roughages and livestock were unimportant except in Townsend, the large township to the north and east of Simcoe. In every case again, cash crops changes indicated a positive shift during the 1961-66 period but livestock declined in importance or merely held steady.

Table 7-8 shows the results for the townships obtaining between $100 and $200 gross farm income per acre. Four townships showed the above results for 1966 — two in Brant County, one in Norfolk and one in Haldimand. The

Table 7-6 (Continued)

County/Township		Norfolk/Windham		Brant/Burford		Norfolk/Middleton	
Commercial Farms	No.	452		392		297	
Total Acreage	Ac.	64,239		60,371		40,754	
Value Added 1966							
—per acre	$	251		249		247	
—per commercial farm	$	35,500		29,700		33,800	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		11,770	18	7,514	12	7,070	17
Grains and cash crops		24,392	38	22,581	38	14,126	35
Improved pastures and roughages		5,690	9	12,289	20	4,242	10
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		1,247		1,973		1,063	
—per commercial farm		2.8		5.0		3.6	
Cattle, horses and sheep		2,671		5,468		1,676	
—per commercial farm		5.9		13.9		5.8	
		Acres		Acres		Acres	
Acres of feed grain/animal unit — hogs and poultry		12.6		9.0		7.5	
Acres of roughage/animal unit — cattle, horses and sheep		2.1		2.3		2.5	
1961-66 Changes		%		%		%	
Acres feed grain and cash crops							
—Actual		+22		+15		+29	
—Shift		+14		+ 4		+20	
Animal units — Hogs and poultry							
—Actual		+44		+20		+60	
—Shift		+23		− 1		+44	
Animal units — Cattle, horses and sheep							
—Actual		−10		−10		+ 5	
—Shift		− 6		− 3		+10	

townships in Brant County were Brantford and South Dumfries, north of the city of Brantford. In Norfolk, the township was Woodhouse in the extreme southeast next to Haldimand County; and in Haldimand, Dunn Township in the east next to the town of Dunnville. Tobacco was not grown in Haldimand's Dunn Township or in Brant's South Dumfries. For the other two townships in the group, tobacco declined to less than 10 percent of total farmland. Cattle and roughage production became a more important part of the agriculture in all of these townships.

However, in both Brantford and Dunn Townships, cattle declined in importance between 1961 and 1966. This decrease was offset by an increasing importance of grain and cash crops in Brantford Township and of hogs and poultry in Dunn Township. In fact, Dunn Township entered this group because of a sharp increase in poultry during the 1961-66 period. This could have resulted from the building of a couple of quite large poultry enterprises in the township during this time period. Woodhouse, in contrast to the other Norfolk County township listed in Tables 7-6 and 7-7, remained static in development of cash crops and increased cattle production. South Dumfries Township in Brant County increased productivity in every category but especially in production of feed grains and cash crops.

Table 7-9 shows the results obtained by the 3 townships within the survey area which were above the 1966 Ontario average gross farm income per acre of $71 but less than $100. This group included Onondaga, the south-eastern township of Brant County and the two northern and western townships of Haldimand County — Walpole and Oneida.

These townships rely heavily on cattle as a main enterprise, averaging about 30 animal units per farm and between 40 and 50 percent of total farmlands in improved pasture and roughages. In all three of these townships, grains and cash crops are important, but tobacco is not grown, and only in the two Haldimand County townships did cash crops increase in importance between 1961 and 1966. However, in all three, all types of livestock production increased in importance during the 1961-66 period. Thus, in 1966 these three townships were above the Ontario average gross farm income per acre of land farmed; the numbers of hogs, poultry and cattle kept increased at a rate faster than that in the 12 southern Ontario counties bordering on Lake Erie.

Table 7-10 shows the results obtained on the remaining townships in Haldimand County. They were lower than the Ontario average in gross farm income per acre of land in 1966. These

Table 7-7/Gross Farm Income 1966, Land Use and Livestock Numbers and 1961-66 Changes Townships Between $200 and $240 Value Added Per Acre.

County/Township		Norfolk/Houghton		Norfolk/S. Walsingham		Norfolk/Townsend	
Commercial Farms	No.	197		195		404	
Total Acreage	Ac.	28,438		27,686		62,168	
Value Added 1966							
—per acre	$	217		207		202	
—per commercial farm	$	32,500		29,200		30,600	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		4,830	17	3,875	14	7,240	11
Grains and cash crops		8,898	31	11,158	40	22,715	37
Improved pastures and roughages		2,215	8	2,651	10	16,988	27
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		435		1,036		2,479	
—per commercial farm		2.2		5.3		6.1	
Cattle, horses and sheep		915		1,073		7,809	
—per commercial farm		4.6		5.5		19.3	
		Acres		Acres		Acres	
Acres of feed grain/animal unit — Hogs and poultry		11.3		7.9		6.8	
Acres of roughage/animal unit — Cattle, horses and sheep		2.4		2.5		2.2	
1961-66 Changes		%		%		%	
Acres feed grain and cash crops							
—Actual		+18		+27		+14	
—Shift		+ 8		+13		+14	
Animal units — Hogs and poultry							
—Actual		+25		— 3		— 6	
—Shift		+ 5		—20		—26	
Animal units — Cattle, horses and sheep							
—Actual		—15		—22		— 5	
—Shift		—15		—17		+ 3	

townships comprise the eastern two-thirds of the county except for Dunn Township which is listed in Table 7-8 because of an expansion of the poultry industry on a few farms in the 1961-66 period.

These townships have less than 30 percent of their farmland in grains and cash crops and, except for Moulton and Sherbrooke, around 50 percent of farmland in roughage crops and improved pasture. Seneca, Moulton, South Cayuga and North Cayuga all had a rise of hogs and poultry greater than the area averages between 1961 and 1966. Seneca, Rainham, Canborough, North Cayuga and Sherbrooke all had above average growth in numbers of cattle kept. In general, except for South Cayuga, the growth of cash crops (the sector involved in intensification of land use) in these townships was less than the growth achieved in most of the other townships in the Study Area. Growth in the area was sharply up for hogs and poultry in the townships listed above but cattle growth was barely significant except for Canborough. This area of Haldimand County thus seems to be improving productivity by adding hogs and poultry in about half the area, and by intensifying cattle production slowly.

Table 7-6 indicates that the central townships of Norfolk County and south-western townships of Brant County have a high gross farm income per acre which is dependent upon the tobacco crop. This crop gives the area a substantial advantage in productivity per acre and the shift analysis indicates that this competitive advantage improved in the 1961-66 period. Roughage growing and cattle populations are a minor part of the agriculture of this area and continued to decline in importance in the 1961-66 period. Hogs and poultry also were a minor part of the industry of these townships but grew in importance in Oakland, Windham and Middleton Townships.

Table 7-7 lists three more townships in Norfolk County — two in the western part of the county, and Townsend in the northeast section — which obtained slightly lower value added per acre than the first group. These townships also depend on tobacco as the main crop providing a high value added return. The shift anaylsis indicates that only in cash crops was the area gaining in importance in productivity levels. Only in Townsend Township, where cattle were more important, were livestock a factor in the agriculture production.

In Table 7-8, the two northern townships of Brant County, the most southeasterly township in Norfolk and one small township near Dunnville in Haldimand are listed. These townships average gross farm income per acre of between $100 and $200. Dunn, in

Table 7-8/Gross Farm Income 1966, Land Use and Livestock Numbers and 1961-66 Changes Townships Between $100 and $200 Value Added Per Acre.

County/Township		Brant/Brantford		Norfolk/Woodhouse		Brant/S. Dumfries		Haldimand/Dunn	
Commercial Farms	No.	322		212		216		62	
Total Acreage	Ac.	67,355		29,352		45,371		12,418	
Value Added 1966									
—per acre	$	167		159		118		101	
—per commercial farm	$	30,000		21,600		20,100		19,700	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		2,638	4	2,270	8	34	—	—	—
Grains and cash crops		33,814	50	8,644	29	16,653	37	3,242	26
Improved pastures and roughages		19,041	28	11,260	38	17,488	39	5,300	43
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		3,212		1,319		2,818		1,061	
—per commercial farm		10.2		6.2		13.0		17.1	
Cattle, horses and sheep		8,442		3,758		10,069		1,263	
—per commercial farm		26.2		17.7		46.6		20.4	
		Acres		Acres		Acres		Acres	
Acres of feed grain/animal unit — Hogs and poultry		6.2		4.8		5.2		3.1	
Acres of roughage/animal unit — Cattle, horses and sheep		2.3		3.0		1.7		4.2	
1961-66 Changes		%		%		%		%	
Acres feed grain and cash crops									
—Actual		+30		0		+14		− 12	
—Shift		+29		0		+20		− 1	
Animal units — Hogs and poultry									
—Actual		+18		+ 9		+27		+161	
—Shift		− 2		− 9		+ 3		+145	
Animal units — Cattle, horses and sheep									
—Actual		− 7		+ 7		+ 5		−17	
—Shift		− 1		+11		+ 4		−17	

Table 7-9/Gross Farm Income 1966, Land Use and Livestock Numbers and 1961-66 Changes Townships Between $70 and $100 Value Added Per Acre.

County/Township		Brant/Onondaga		Haldimand/Oneida		Haldimand/Walpole	
Commercial Farms	No.	119		160		336	
Total Acreage	Ac.	20,507		34,653		64,837	
Value Added 1966							
—per acre	$	97		79		76	
—per commercial farm	$	14,800		16,700		14,100	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		—	—	—	—	—	—
Grains and cash crops		9,099	44	10,537	30	18,601	29
Improved pastures and roughages		8,141	40	16,783	48	33,642	52
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		1,500		1,539		2,776	
—per commercial farm		12.6		9.6		8.3	
Cattle, horses and sheep		3,539		5,421		10,805	
—per commercial farm		29.7		33.9		32.2	
		Acres		Acres		Acres	
Acres of feed grain/animal unit—Hogs and poultry		5.4		5.7		5.3	
Acres of roughage/animal unit—Cattle, horses and sheep		2.3		3.1		3.1	
1961-66 Changes		%		%		%	
Acres feed grain and cash crops							
—Actual		0		+ 5		−11	
—Shift		0		+22		+10	
Animal units — Hogs and poultry							
—Actual		+45		+41		+20	
—Shift		+23		+22		+ 1	
Animal units — Cattle, horses and sheep							
—Actual		+ 8		+ 4		+ 4	
—Shift		+15		+ 9		+10	

Table 7-10/Gross Farm Income 1966, Land Use and Livestock Numbers and 1961-66 Changes Townships Under $70 Value Added Per Acre.

County/Township		Haldimand/Seneca		Haldimand/Rainham		Haldimand/Moulton		Haldimand/S. Cayuga	
Commercial Farms	No.	163		135		89		59	
Total Acreage	Ac.	38,003		25,210		20,971		12,356	
Value Added 1966									
—per acre	$	67		66		61		60	
—per commercial farm	$	14,900		11,900		13,000		12,000	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		—	—	—	—	—	—	—	—
Grains and cash crops		10,519	28	6,995	28	6,560	31	3,135	25
Improved pasture and roughages		19,004	50	13,348	53	6,982	33	5,991	48
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		1,933		823		1,027		473	
—per commercial farm		11.9		6.1		11.5		8.0	
Cattle, horses and sheep		5,076		3,783		2,069		1,610	
—per commercial farm		31.1		28.0		23.2		27.3	
		Acres		Acres		Acres		Acres	
Acres of feed grain/animal unit — Hogs and poultry		5.0		7.3		4.6		5.9	
Acres of roughage/animal unit — Cattle, horses and sheep		3.7		3.5		3.4		3.7	
1961-66 Changes		%		%		%		%	
Acres feed grain and cash crops									
—Actual		—11		—14		+ 2		+14	
—Shift		+ 6		+10		— 6		+42	
Animal units — Hogs and poultry									
—Actual		+36		+ 8		+54		+56	
—Shift		+15		—10		+32		+35	
Animal units — Cattle, horses and sheep									
—Actual		— 1		+ 6		—12		— 8	
—Shift		+ 2		+13		— 5		— 3	

County/Township		Haldimand/Canborough		Haldimand/N. Cayuga		Haldimand/Sherbrooke	
Commercial Farms	No.	75		138		10	
Total Acreage	Ac.	20,659		32,714		4,060	
Value Added 1966						45	
—per acre	$	57		56			
—per commercial farm	$	14,700		12,800		16,700	
1966 Land Use		Acres	% of Total	Acres	% of Total	Acres	% of Total
Tobacco		—	—	—	—	—	—
Grains and cash crops		4,719	23	7,320	22	829	20
Improved pasture and roughages		11,085	54	18,170	56	1,410	35
1966 Livestock Numbers		Animal Unit		Animal Unit		Animal Unit	
Hogs and poultry		458		1,133		81	
—per commercial farm		6.1		8.2		8.2	
Cattle, horses and sheep		3,038		4,591		419	
—per commercial farm		40.5		33.3		41.9	
		Acres		Acres		Acres	
Acres of feed grain/animal unit — Hogs and poultry		8.6		5.4		6.2	
Acres of roughage/animal unit — Cattle, horses and sheep		3.6		4.0		3.4	
1961-66 Changes		%		%		%	
Acres feed grain and cash crops							
Actual		— 2		— 8		—24	
Shift		+18		+18		—22	
Animal units — Hogs and poultry							
Actual		+11		+55		—44	
Shift		—10		+34		—65	
Animal units — Cattle, horses and sheep							
Actual		+24		+ 4		+ 4	
Shift		+33		+ 6		+ 5	

Summary and Recommendations

Haldimand County, was included only because of a sharp increase in hogs and poultry numbers in the 1961-66 period. Tobacco was a minor crop in the other three townships. However, Woodhouse, the Norfolk County township in the group, showed very little change in production of cash crops in the 1961-66 period. The two Brant County townships were listed in this group because of improvement in general cash crop production and maintenance of a relatively high livestock population.

Table 7-9 lists the most easterly township (Onondaga) in Brant County and the two most westerly townships in Haldimand County. These had a gross farm income of under $100 per acre but above the Ontario average of $71. Tobacco is not grown in these townships and cash crops are not important. Improvement in productivity was shown between 1961-66 by an increase of both kinds of livestock.

Finally, Table 7-10 lists the remaining townships in Haldimand County where roughages and cattle provide the dominant type of agriculture. Hogs and poultry, and feed and cash crops are increasing in importance in Seneca, Moulton, South Cayuga and North Cayuga, but these changes had not brought productivity up to the Ontario average by 1966. Only in Canborough Township did the cattle industry increase sharply in the 1961-66 period. Tobacco, of course, is not grown in this area.

The analysis indicates that wherever tobacco is grown farming is relatively profitable. On the other hand, in the townships of Haldimand where clay soils predominate productivity is below the Ontario average. Although hogs and poultry are increasing in importance in Haldimand County, other types of farms are declining in importance in Haldimand except in the central part of the county around Cayuga.

An analysis of the project area by townships used two techniques. The first used census and Statistics Canada data to obtain estimates of the value of the production within townships during 1966. The second used the 1961 and 1966 census data of land use and livestock numbers to indicate the changes occurring in these townships during that period. The shift analysis also estimated percentage shifts which were greater or less than those occurring in 12 southern Ontario counties at the same time.

The estimates of gross farm income indicated the gross value productivity of the agricultural sector. The changes indicated the extent of farmers' adjustments to economic conditions. Since Ontario farmers have been subjected to economic pressures which reduced unit profitability during that time, changes which intensified land use and livestock production greater than the averages indicated an economic adjustment for the farmers in those townships which was greater than the average. Shifts to more cash crops and more hogs and poultry were changes which indicated intensification of production.

The analysis indicated that in most of the townships of Brant and Norfolk Counties farms had high gross farm incomes. These high gross farm incomes were related to the amount of land used for tobacco, a crop which has a high sale value per acre. In addition, many of the farmers in these townships were increasing land use intensity and livestock production. Brantford, South Dumfries, Oakland and Onondaga Townships in Brant County and Charlotteville, Middleton and Windham Townships in Norfolk County were the townships which had considerably above average shifts of cash crops and hogs and poultry.

However, the analysis indicated that most of the townships in Haldimand County had gross farm incomes of about the Ontario average. Although much of the land in this county is rated high by the Canada Land Classification System, the present land use is quite extensive. However, shifts to cash crop production and intensive livestock production through hogs and poultry were occurring at a fast rate in some of the townships — namely, North Cayuga, South Cayuga, Dunn and Oneida Townships.

Thus, in the parts of the Study Area where tobacco was grown gross farm incomes were high. Also, many of the farmers on this land were adjusting to economic conditions at a rate faster than expected. These lands now contribute substantially to the value of Ontario agriculture production. The loss of these lands to agriculture would lower the value of agricultural production for some time until new areas could be put into tobacco. Also, considerable amounts of new investment would be needed to bring these areas into production.

On the other soils of the area gross farm incomes were at the Ontario averages. Relatively fast adjustments were occurring in about four of the ten townships of Haldimand County. Taking this land out of agriculture would have less effect on total agricultural production of Ontario since many other areas of the province or of Canada could supply this production with minimal adjustment costs.

Recommendations

1) Tobacco land which has uses for other crops should remain in tobacco as long as demand is sufficient to require its use for this purpose. But this land also has a high value use in agriculture, producing other crops such as fruits, vegetables and specialized canning and field crops. This land will have an economic advantage for these crops because of favorable climate and location close to markets. These soils should remain in agriculture for potential change to other crops if demand for tobacco declines.

2) The other Class 1, 2 and 3 soils in the project area should be reserved for agriculture. These are being used at the present time for relatively low value crops. The intensity of this land use is below the rate expected when the favorable climate and location is considered. Under the present economic conditions in Canada it is likely that this land could be diverted to non-agricultural uses with a minimum effect

on Canada's farm output since other areas of Canada could supply these products with low resource reallocation costs. However, the future demand for specialized agricultural products which are limited to the favorable climatic zone of the project area may provide an economic advantage not being exploited by the present farmers. Thus it is recommended that this land be reserved to remain in agriculture until more detailed studies are completed which indicate that future demand for products such as fruits, vegetables, and canning crops are being met by production from other areas.

3) Waste disposal sites be limited to soil capability waste disposal Classes 1 and 2. It is imperative that poorly drained soils, shallow soils, organic soils, and flood plains be avoided for waste disposal. It is also suggested that some use other than dumping sites be designated for disused gravel pits and quarries.

4) Contractors are urged to avoid clay soils when wet. When clay soils are worked or otherwise disturbed while wet, the clays flow together. Soil structure is then destroyed and the soil becomes very hard on drying. Hard, lumpy clays are most difficult for the landscaper and gardener to work with.

5) It is recommended that farmers cultivate land no closer than 50 feet to an open body of water or stream. Keeping stream banks and adjacent land under a permanent cover of grass or trees will reduce erosion which, in turn, will reduce stream pollution.

6) No new subdivision or other building project should be undertaken without a detailed soil survey. Such a soil survey will provide information that will save the subdivider money and embarrassment. Interpretation of the soil survey indicates the limitations of soil to urbanization.

Footnotes

1. The rolling soils of the region have been separated into slope phases because slope often affects use. The significance of slope varies. Class 1 soils for agriculture are limited to slopes of 5 percent or less, while a much greater range of slope is permissible for Class 1 soils for recreation.
2. *The Challenge of Abundance, The Report of the Special Committee on Farm Income in Ontario,* January, 1969, p. 34.
3. Rodd, R. S. *Shift Analysis of Ontario Economic Regions,* Department of Agricultural Economics, University of Guelph, unpublished.
4. Perloff, Harvey S., E. S. Dunn, E. E. Lawford, and R. F. Muth. *Regions Resources and Economic Growth.*
5. Brant, Elgin, Essex, Haldimand, Kent, Lambton, Lincoln, Middlesex, Norfolk, Oxford, Welland, Wentworth.

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Introduction

Lake Erie fronting Haldimand and Norfolk Counties supports a highly productive commercial fishery centered at Port Dover and Port Burwell, with lesser ports at Dunnville, Port Rowan, and Nanticoke. Important sport fisheries are located along the shore with a major warmwater fishery provided by Long Point Bay. Limited warmwater sport fisheries are located, also, in the lower reaches of the Grand River, Big Creek, and several of the smaller watersheds. The lower Grand River supports, as well, a commercial coarse fish fishery.

The watersheds of Norfolk County, noted historically for their native speckled trout production, continue to provide excellent local angling although, in recent years, the exotic rainbow trout has increased in importance to provide a fishery for which the county has become famous. Seasonal fishing for rainbow trout and, recently, Pacific salmon in Lake Erie and several Haldimand and Norfolk County estuaries complement the traditional fishery. Sport fishing in Haldimand County is now limited essentially to warmwater species in the Grand River and a few headwater trout streams, mostly upriver from the Study Area.

This chapter appraises the present fish resources within Haldimand and Norfolk Counties and points out past and present land and water use practices which have destroyed or have been detrimental to local fisheries and continue to threaten the future welfare of both sport and commercial species. Recommendations are made to ensure perpetuation and improvement of the present highly valuable fish species of the lake and inland waters which are of significant social and economic benefit to the region. In viewing these recommendations, it must be appreciated that waters environmentally suitable for preferred fish species generally meet, also, those water quality standards demanded by society for maximum health, social, recreational, and economic benefit. Intensive management of the Haldimand-Norfolk region for fisheries, therefore, ensures wise land and water policies in the best long-term public interest.

Inland Fisheries of Haldimand County

Salmonid Fishes

Resident salmonid fishes are believed to be absent from the inland waters of Haldimand County because of unfavorably warm water temperatures during the summer months, and a typically unfavorable aquatic environment in most waters. However, adult rainbow trout *(Salmo gairdneri)* do migrate annually from Lake Erie up the Grand River as far as the dam at Brantford. The extent of the spawning run is not known but fishing of the species is negligible in comparison to that of warmwater fishes. Likewise the success of spawning is unknown but a significant survival would be unlikely because of the heavily silted river bed, generally unfavorable habitat, and the presence of predator fish and bird species.

Other Haldimand watersheds tributary to Lake Erie are turbid, silted, variable in flow, and thermally unsuitable for coldwater fishes. Isolated quarries near Hagersville present limited habitat potentially suitable for hatchery-reared rainbow or brown trout managed on a put-take basis.

A few rainbow trout are taken by commercial gill net fishermen in Lake Erie fronting Haldimand County but small numbers of coho salmon *(Oncorhynchus kistuch)* are being taken since its recent introduction to Lake Erie.

Coldwater commercial fish which were once of major economic importance in Lake Erie are now limited to occasional captures of whitefish *(Coregonus clupeaformis)* and cisco *(Coregonus artedi).*

Warmwater Fishes

Only the Grand River watershed sustains significant inland populations of preferred warmwater species. All smaller watersheds, excepting Mill Creek and parts of Mackenzie Creek (Oneida Township), generally lack summer flows and water quality necessary to sustain summer populations. However, virtually all tributaries to the lower Grand River experience spawning runs of warmwater fish, especially northern pike *(Esox lucius),* suckers *(Catostomus),* carp *(Cyprinus carpio),* and some yellow pickerel *(Stizostedion virtreum).* These species may migrate several miles to headwater marshes and lowlands.

Northern pike, carp, suckers, pickerel, as well as smallmouth bass *(Micropterus dolomieu),* largemouth bass *(Micropterus salmoides),* yellow perch *(Perca flavescens)* and bullheads *(Ameiurus sp.),* are permanently resident in the main Grand River throughout Haldimand County.

The northern pike is classed as a coarse fish and, along with carp, may be taken by dip nets, spearing, or bow fishing during the spring months and by angling during the rest of the year. The pike is not highly regarded as a sport fish by local anglers and commercial catches in the lower Grand and adjacent Lake Erie are small.

Pickerel ascend the lower Grand from Lake Erie where some reproduction occurs. There is a significant commercial estuarial and lake fishery for the species and some angling. Because of the unliklihood of the species surmounting the dams at Dunnville, the small number of pickerel taken by anglers between Dunnville and Newport seem to be the result of local natural reproduction. There is no closed season locally on the species. Populations of largemouth bass in the lower Grand River seem to be only modestly exploited.

Coarse fish which are resident in the Grand River through Haldimand County are no more abundant than in the lower river and estuary where there is both a significant sport and commercial fishery. In addition to yellow perch, white bass, sheepshead *(Aplodinotus grunnieus),* bullheads, rock bass *(Ambloplites rupestris)* and sunfish *(Lepomis sp.),* incidental captures of largemouth and smallmouth bass are not uncommon.

Lake Erie Fisheries Fronting Haldimand County

The *yellow perch* is abundant along the Lake Erie shoreline of Haldimand County, particularly during the spring months, and is an important sport on various lake shoals and in the lower reaches of the Grand River. It is also the major commercial species of the Dunnville-based fishing tugs.

The *American smelt* moves onshore to spawn along the Haldimand shoreline at which time virtually unlimited quantities of the species are available for sportsmen using dip nets and seines. It provides the second largest catch by species to the Dunnville commercial fishermen but is of considerably less poundage and value than the yellow perch. The white bass is comparatively low in number but offers a limited sport fishery; it is readily marketed by commercial operators at a favorable price.

Table 8-1/Average Annual Harvests of Commercial Fish from the Lower Grand River and Lake Erie Fronting Haldimand County

Species	Pounds	Percent of Total for Lake Erie
Perch	1,038,313	5.5
Smelt	168,801	1.3
Pickerel	36,961	6.1
Suckers	16,434	26.0
Carp	18,278	11.1
White bass	2,995	1.0
Catfish	1,987	1.5
Sheepshead	1,955	0.3
Bullhead	1,324	7.3
Rock bass	765	0.2
Pike	91	1.9
Whitefish	41	1.4
Sunfish	22	0.2
Total Pounds	1,299,021	3.9
Bait Fish Sales	325,000 dozen	10.5
Approximate Value	$90,000	

Sport Fishes

The *smallmouth bass* is the prized sport fish of the Haldimand and Long Point Bay region of Lake Erie, and occurs in the Grand River from the estuary northward.

Important spawning grounds for the smallmouth bass occur in numerous locations along the Haldimand shoreline of Lake Erie. Bass produced on spawning shoals fronting Walpole Township not only contribute to the significant offshore sport fishery on "Three-mile Shoal" but recent tagging of parent bass by the Department of Lands and Forests shows that the Wa'pole spawning population contributes substantially to the fishery of Norfolk County, including Inner Long Point Bay.

Other major spawning areas for smallmouth bass front Rainham, South Cayuga, and Dunn Townships between Miller Bay and Blatt Point, and Sherbrooke and Moulton Townships between Mohawk Point and the Haldimand-Welland County line. Major sport fisheries occur in these regions as well as offshore at Tecumseh and Hog Back Shoals (off Dunn Township), and the Mohawk Island Shoal (off Sherbrooke Township) and off the mouth of the Grand River. The population of smallmouth bass in the Grand River is greater than generally recognized and offers sport fishery greater than now realized.

Commercial Fishes

Commercial fishermen are based at Nanticoke and at the mouth of the Grand River. Also, fishermen from other Lake Erie ports use the commercial lake fishery in the waters off Haldimand County. Presently there are 12 active gill net fishermen based at the 2 above-mentioned ports. A number of part-time operators fish coarse species in the lower Grand River to Dunnville and occasionally above, using hoop nets, seines, trammel nets and baited hooks.

That Haldimand commercial fishery is composed essentially of warmwater species, with the exception of a few whitefish, indicates the thermal and other environmental changes which have occurred in Lake Erie in a quarter of a century. Perch and pickerel are the prime species in terms of quality and market value although the smelt, because of its abundance, is economically important. All species harvested from Lake Erie fronting Haldimand County and the lower Grand River are of acceptable quality and readily marketed. Annual harvests of over a million pounds (3.9 percent of the entire catch from the Canadian waters of Lake Erie) are realized by commercial fishermen based in Haldimand County. In addition, licenced bait fish fishermen harvest between 300,000 and 350,000 dozen lake emerald shiners annually from the area (10.5 percent of the total Lake Erie production).

A summary (five-year average) of commercial fishing statistics for Haldimand commercial fishermen is given in Table 8-1.

Inland Fisheries of Norfolk County

Salmonid Fisheries

The inland salmonid fisheries of Norfolk County are a valued recreational resource maintained by natural reproduction and plantings of hatchery-reared trout. Two government operated trout rearing stations are located in Charlotteville Township, and there are 3 private commercial trout production operations in that township.

The native brook trout *(Salvelinus fontinalis),* although its pristine distribution has been limited by the effects of past and present land use practices, is generally distributed in waters of the county. Self-sustaining populations of the species occur in a number of tributaries but government policy relies on substantial annual plantings of hatchery-reared brook trout to supplement an unknown amount of natural reproduction. The relative contribution of natural and hatchery-reared brook trout to the fishery is not known.

The exotic brown trout *(Salmo trutta),* introduced to waters of the county many years ago, is totally self-sustaining in the colder parts of most watersheds and, because of migratory tendencies, provides some angling in the larger rivers and their lower reaches. Odd specimens are caught by Lake Erie gill net fishermen. The species provides acceptable continuous stream angling for the experienced fishermen.

The rainbow trout *(Salmo gairdneri)* is migratory to virtually all watersheds of Norfolk County thermally capable of supporting coldwater fish species, except for the limited trout headwaters of Nanticoke Creek and the Lynn River where adult lake fish do appear seasonally at the mouth.

Lake-run rainbow trout, because of their large size, are a trophy species, and provide active onshore lake sport fisheries near river mouths, in estuaries, and in the lower reaches of nearly all watersheds during the autumn months. An extended fall fishing season for rainbow trout is provided by regulation in several watersheds. While the smaller watersheds provide fall and spring angling for migrating adult trout, by far the most important watershed is Big Creek in which the upriver movement of parent fish is unimpeded by dams to the town of Delhi. Below this town are over 20 miles of main river, one large tributary (Venison Creek), and numerous small tributaries to which the fish have free access. The mill dam at Delhi prevents further migration up the main river but a local fishery through Windham Township is provided by hatchery-reared fish. The recently constructed dam on North Creek has flooded excellent rainbow trout spawning areas but the fish ladder permits access of lake-run fish to the south branch and headwaters above the impoundment. Actual numbers of adult trout ascending the fish ladder are not known although upwards of 300 fish have been tagged at the site during the spring run. Extensive spawning now occurs in a stretch of Big Creek below the North Creek dam.

Normandale and Fishers Creek are small watersheds supporting noteworthy spawning runs of rainbow trout as well as resident populations of brook trout. A fish hatchery is located on each watershed. Young Creek is an excellent trout stream with annual migrations of rainbow trout upstream to the Vittoria dam where migration is blocked. The lower reaches support a significant brook trout fishery whereas planted rainbow and naturalized brown trout are more common above Vittoria.

In addition to the fishery for adult rainbow trout, young fish are abundant in the colder parts of nearly all watersheds and provide a popular spring and summer sport fishery. The relative contribution of naturally produced and hatchery-reared fish to the rainbow and brook trout populations of Norfolk County is not known. Although present rainbow trout resources in the watersheds of Norfolk County and Lake Erie provide excellent sport fishery, neither the extent of the resource nor its level of exploitation are known. Public angling for brook and rainbow trout is provided in the impoundment at the St. Williams nursery, and in several of the Big Creek Conservation Authority ponds. One of the Waterford ponds is stocked annually with rainbow trout for public recreation. Private trout fishing is provided by a number of small impoundments on tributary creeks and by dugout ponds.

Present coldwater environments and valuable salmonid resources are threatened by present land and water use practices in Oxford and Norfolk Counties. Particularly serious are the excessive use of surface water for irrigation, the drainage of wetlands, and a disregard for soil conservation practices on lands bordering on watercourses.

Warmwater Fishes

Warmwater sport fishes are of minor consequence in Norfolk County in comparison to the trout species. The larger rivers (Big Creek, Dedrick Creek, Lynn River) provide warmwater environments suitable for a variety of species and fishing for coarse fish and pan fish from the bank or bridges provides considerable recreation at nominal cost.

Pike and largemouth bass are generally resident and there are extensive runs of pike, suckers, and some pickerel into each of the above-noted watersheds. A number of dugout ponds are suitable for largemouth bass and the species would seem suited to several of the impoundments created by the Big Creek Conservation Authority.

Lake Erie Fisheries Fronting Norfolk County

Figure 8-1/Commercial fishing in Lake Erie. Seine fishery for carp in Inner Point Bay.

Figure 8-2/Part of commercial fishing fleet at Port Dover.

The waters within and fronting Norfolk County provide major sport and commercial fisheries (Map 8-1). Several watersheds (including Otter Creek which lies largely in Elgin County) provide the principal salmonid fishery of southwestern Ontario. Inner Long Point Bay and the shoals of the outer bay are noted for the excellence of their sport fishery for the smallmouth bass *(Micropterus dolomieu)* and other warmwater fish. A thriving commercial fishery harvesting annually over 11 million pounds of fish exists for a variety of prime warmwater food fishes in the outer bay and open Lake Erie. A seasonal commercial coarse fish fishery is carried on in Inner Long Point Bay (Figure 8-1, 2).

Table 8-2/Average Annual Harvests of Commercial Fish from Lake Erie Fronting Norfolk County

Species	Pounds	Percent of Lake Erie Total
Smelt	11,147,913	85.6
Perch	599,611	3.2
White bass	58,334	3.8
Carp	53,479	45.0
Rock bass	52,631	95.0
Sheepshead	36,779	4.8
Bullhead	16,109	88.4
Sunfish	14,163	99.5
Bowfin	10,044	100.0
Suckers	6,355	10.8
Pike	2,113	43.5
Whitefish	1,642	75.0
Pickerel	718	0.1
Ling	319	84.2
Sturgeon	294	24.9
Sauger	88	54.0
Total Pounds	12,000,592	34.7
Bait Fish Sales	350,000 dozen	
Approximate Value	$874,000	

Commercial Fishing

Port Dover is the more active of the two commercial fishing ports in Norfolk County from which a fleet of modern gill net tugs and trawlers operate almost year-round from a modern harbor. Harvest (primarily smelt and perch) are processed locally or trucked to a large processing plant at Wheatley. Port Rowan fishermen operate a seasonal warmwater fishery using onshore seines and live impounding gear for carp and a variety of coarse fish. A unique aspect of the latter fishery is the sale of live panfish for stocking small recreational fishing waters, largely in the United States. It should be noted that Port Burwell (Elgin County) at the mouth of Otter Creek is a very active commercial gill net and trawling port convenient to Lake Erie waters fronting the extreme western part of Norfolk County.

There is an active bait fish fishery in Norfolk County which harvests annually approximately 350,000 dozen minnows, largely lake emerald shiner *(Notropis atherinoides)* from Lake Erie. This represents some 11 percent of the bait fish harvest from the Canadian waters of Lake Erie.

Annual harvest (last available three-year average) of commercial species harvested from waters fronting Norfolk County is given in Table 8-2.

Sport Fishing

In the category of *warmwater fishes,* Inner Long Point Bay is historically a productive sport fishing area particularly for smallmouth bass, although largemouth bass are also abundant as are perch and, to a lesser extent pike. Estimated total harvests of sport fish from Long Point Bay in 1967 by numbers

Inner Long Point Bay Fishery

Table 8-3/Estimated Total Harvest of Sport Fish from Long Point Bay (1967)

Species	Number
Smallmouth bass	97,026
Perch	81,549
Rock bass	32,607
Sheepshead	
Largemouth bass	
Bluegill	1,119
Pike	753
Crappy	441
Yellow pickerel	11

are shown in Table 8-3.
This fishery provided an estimated 294,249 man-hours of recreation annually. Angling is done primarily from private and rental boats with guides available through numerous modern marinas dispersed along the shore from Long Point to Port Dover. Winter fishing for perch and coarse fish is becoming an increasingly popular activity.

Because of the lack of harbour facilities and the exposed shoreline of Lake Erie fronting Houghton and the western part of South Walsingham Townships (*i.e.*, from the Norfolk-Elgin county line to tip of Long Point), sport fishing is very limited there. Intensive angling occurs in Inner Long Point Bay and on the shoals of outer Long Point Bay on Long Point and Turkey Point, and along the shoreline of the western part of Charlotteville and Woodhouse when weather permits. Virtually all wharfs and docks, more notably those at Port Rowan and St. Williams, are used by anglers, and the piers at Port Dover accommodate many fishermen.

Fishing from banks and bridges in the lower reaches of the larger creeks provides popular and low cost recreation for a wide variety of available species, principally coarse fish (bullheads, carp, suckers, panfish, etc.) and some largemouth bass, pike, and even rainbow trout. Public angling from harbor facilities (for example, at Port Rowan, St. Williams, and Port Dover) likewise provides children and adults with angling for a variety of species.

Salmonid Fishes
Migratory rainbow trout and some brown trout move into Lake Erie for growth and maturity where they are occasionally taken by commercial gill nets while frequenting the open lake. Excellent local late autumn sports fisheries occur off the estuaries of several creek systems and within the estuaries. The recently introduced Pacific coho salmon is beginning to appear in modest numbers in commercial gill nets and a few adults are being seen and caught in the river mouths by anglers. Spawning runs of smelt attract numerous net fishermen to the Lake Erie shore each spring.

The sport fishery of Inner Long Point Bay and the shoreline fronting Long Point and the townships of South Walsingham, Charlotteville, and Woodhouse is, therefore, a major recreational resource and one of significant local economic benefit. In view of continuing ecological changes in Inner Long Point Bay, the spawning and fishing shoals, particularly for smallmouth bass, eastward from Turkey Point into Haldimand County become increasingly significant in the future fishery.

Summary and Recommendations

Summary

Recent changes in the species composition and relative abundance of *Lake Erie commercial fishes* reflect rapid changes in the aquatic environment, most notably an increase in water temperature and organic enrichment. The part of the lake fronting Haldimand and Norfolk Counties is highly productive and supports a significant industry at Port Dover, Port Burwell (Elgin County), Port Rowan, and Port Maitland. Inner Long Point Bay and the lower Grand River support coarse fish fisheries. Annual harvests from Lake Erie fronting Norfolk and Haldimand Counties total about 13 million pounds with a landed value approaching $1 million, and make up about one-third of the total Lake Erie catch. In 1969, 57 bait fish and 123 commercial fishing licences were issued (Tables 8-4 and 8-5).

The Lake Erie warmwater sport fishery, renowned for its smallmouth bass, is a most significant recreational resource in Inner Long Point and on shoals of the outer bay fronting Long Point, and Norfolk and Haldimand Counties. Perch, pike, pickerel, smelt, and coarse fish are taken by both the sport and commercial fisheries. Because of the sensitivity of fish species to ecological change, it is imperative that the important fish resources of Lake Erie should not be impaired by an altered littoral limnology resulting from existing or new urban or industrial development along the lake shore.

Inland fisheries resources in Haldimand County are limited more or less to the main Grand River where several warmwater species provide a significant commercial and sport fishery, largely for coarse fish in the lower reaches. Although warmwater fish, including pike, largemouth and smallmouth bass, are resident in the Grand River through the county, the population is not extensively exploited, partly because of public suspicion of the quality of the flesh from impaired river water. With the exception of Mill Creek and part of Mackenzie Creek (Oneida Township), Grand River tributaries generally lack the summer flow and thermal characteristics necessary to sustain useful fish but most tributaries experience spring spawning runs of pike, suckers, carp, some pickerel, and a few rainbow trout.

The inland salmonid fishery of Norfolk County and the adjacent part of Elgin County is a remarkable recreational resource which distinguishes watersheds in these two counties from others in southwestern Ontario. The native brook trout is a significant species although its range has been reduced by the adverse effects of land and water use practices. The exotic brown trout is self-sustaining in several waters. The introduced rainbow trout provides a continuing fishery with lakerun fish being particularly prized when caught in the streams and along the lakeshore. Variable stream flow and siltation, resulting from agriculture, are primary factors in limiting natural reproduction and abundance of salmonids. Natural reproduction is supplemented by a stocking program (Table 8-6).

Warmwater sport fish are of minor importance in comparison to trout in the inland waters of Norfolk County. Big Creek, Dedrick Creek, and the Lynn River provide warmwater environment

Table 8-4/Revenue Derived from Sale of Special Licences and Permits in the Haldimand-Norfolk Region. (Regular Hunting and Angling Licences not Included.)

	Type or Location	Number	Revenue	Total Revenue ($)
Trapping licences	resident	167	$ 835.00	
	registered trapline	10	50.00	
	Total	177		885.00
Fur farmer licences	Norfolk	10	100.00	
	Haldimand	13	130.00	
	Total	23		230.00
Township hunting licences	Resident—Haldimand	733		
	—Norfolk	1,483		
	Non-resident —Haldimand	1,830		
	—Norfolk	1,313		
	Total	5,349		11,945.00
Hunting reserve licences	Norfolk	2	200.00	
Pheasant farms	Norfolk	5	50.00	
Long Point waterfowl unit permits	Zone A	1,144		
	Zone B	330	5,696.00	
	Total	1,481		5,946.00
Bait fish licences	seine	27	270.00	
	dip	3		
	trap	2		
	dealers	23		
	preserving	2		
	Total	57		529.00
Commercial fishing	gill	87		
	trawl	30		
	seine	2		
	hoop	4		
	Total	123		7,562.00
Total licences and permits		7,220		27,097.00

Table 8-5/Value of Fish and Fur Resources Harvested Commercially from the Haldimand-Norfolk Region in 1968-69.

Furbearers	Species	Number	Value ($)	Total Value ($)
(value to trapper)	fox	19	219.45	
	mink	245	2,658.25	
	muskrat	17,745	25,197.90	
	raccoon	417	2,585.40	
	beaver	8	141.60	
	Total	18,434		30,802.00
Fish	County	Pounds	Value ($)	
(landed value)	Haldimand	1,299,021	90,000.00	
	Norfolk	12,000,592	874,000.00	
	Total	13,299,613		964,000.00
Total Value				994,802.00

for a variety of coarse and panfish in their lower reaches and, thereby, provide considerable public recreation at nominal cost. A number of dugout ponds in Norfolk County, many built primarily for irrigation and fire control, are suitable for either largemouth bass or rainbow trout for which there is some commercial sale of angling.

Recommendations

1) In view of the importance of the commercial fishery (harvest of over 13 million pounds; landed value of nearly $1 million in 1968-69) and the high socio-economic value of the sport fishery within the Haldimand-Norfolk region, every effort must be made to sustain or improve this outstanding resource through necessary bio-ecological research and the establishment of standards of environmental quality which must be met in present and future agricultural, industrial and urban development.

2) Increased effort must be forthcoming to assess the quality of the aquatic environment within the region so that existing sources of mechanical, chemical, and biological pollution may be eliminated and further deterioration of natural waters prevented. A much greater emphasis must be placed on the investigation of the extent and effects of sub-lethal levels of heavy metals, and industrial and agricultural chemicals on the welfare of local fish and the quality of flesh for human consumption. A continuous monitoring program is essential.

3) A specific and detailed study of the biology of the smallmouth bass, and associated species, in the Long Point Bay area must be given a high research priority in view of the importance of the fishery and the rapid ecological changes occurring in Inner Long Point Bay, the present construction of the hydro generating plant at Nanticoke, and the proposed new industrial developments along the lakeshore. Findings resulting from this study are essential to provide data on which to base wastewater discharge and general environmental quality standards.

4) In view of the increasing leisure time within society and the need for greater opportunities for outdoor recreation, immediate steps should be taken to facilitate public use of the abundant fisheries resources of Lake Erie. Public access and boat launching ramps should be provided at all suitable locations along the shore — in protected bays, at river mouths, and especially in the areas of Turkey Point, Inner Long Point Bay, and the lower Grand River. Consideration should be given to the erection of fishing platforms or piers in Inner Long Point Bay to increase the opportunity for shore fishermen.

5) In view of the present government and public concern over pesticide, heavy metal, and other chemical residues in the fish from Lake Erie and other waters, the public must be kept informed on the current status of all species and encouraged to use those fish which are safe for human consumption. Otherwise, adverse publicity on the dangers of eating Lake Erie sport and commercial fish will have most serious social and economic consequences.

6) As the watersheds of Norfolk County are a unique and important phenomenon within southwestern Ontario because of the resident and migratory salmonid fish populations which they support, it is imperative that research be initiated immediately on the biology of brook, rainbow and brown trout relative to their ecological requirements and the present status of the stream environments. Pollution of agricultural and urban origin is obvious but precise environmental problems must be identified in order that appropriate corrective and management procedures may be implemented to increase salmonid production and the use of this resource for optimum social and economic benefit.

7) It is necessary to establish an integrated coldwater fish management plan for Norfolk County, Bayham Township (east Elgin County), and the southern part of Oxford County to include the Big and Little Otter Creeks, Clear Creek, Big Creek, Dedrick Creek, Young Creek, headwaters of the Lynn River, and the several small watersheds in Charlotteville Township. This plan would be based on a comprehensive inventory of the aquatic environment and its present and potential fisheries resources. It should set forth a future land and water management policy for the effective preservation and improvement of the water courses, and incorporate all effective fish management procedures. The plan must include river bank and other land acquisition and be integrated within a general land and water use policy embracing wildlife production and other recreational and esthetic values of these unique river valleys.

8) A detailed study of the lower Grand River is required to assess the parameters of the present fisheries resources and to identify adverse environmental conditions and their origins. Pollution abatement is imperative as part of a

able 8-6/Plantings of Salmonid Fishes in Haldimand-Norfolk Region During 1968.

/ater	Township	County	Number Stocked (2-yr.-olds)	(yearlings)
ainbow Trout				
ig Otter	Bayham	Elgin	500	2,700
ittle Otter	Bayham	Elgin	—	1,100
enison	N. Walsingham	Norfolk	1,600	—
pooky Hollow	Charlotteville	Norfolk	50	—
oung	Charlotteville	Norfolk	250	—
otters	Charlotteville	Norfolk	150	—
lear	Houghton	Norfolk	—	600
hub	Houghton	Norfolk	—	400
tter Pond	Bayham	Elgin	500	600
cCuere's Pond	Houghton	Norfolk	—	600
onservation uthority	(Waterford S.	Norfolk	1,200	2,900
onds	(Waterford N.)	Norfolk	300	600
ublic Fishing	(Normandale)	Norfolk	1,450	2,100
onds	(St. Williams)	Norfolk	2,950	4,400
rook Trout				
enison	S. Walsingham	Norfolk	—	2,966
atterson	Windham	Norfolk	—	1,200
edricks	S. Walsingham	Norfolk	—	590
ooky Hollow	Charlotteville	Norfolk	—	800
aint Mill	S. Walsingham	Norfolk	—	1,400
ent	Charlotteville	Norfolk	—	300
uck	Malahide	Elgin	—	300
lear	Houghton	Norfolk	—	300
lver	Malahide	Norfolk	—	300
all	Houghton	Elgin	—	300
athews	Houghton	Norfolk	—	300
ofe	Bayham	Elgin	—	300
oung	Charlotteville	Norfolk	—	200
tter	Bayham	Elgin	—	750
ublic	(St. Williams)	Norfolk	—	2,200
hing	(Normandale)	Norfolk	—	900
nds	(Staffordville)	Elgin	—	400
otal Rainbow Trout			8,950	16,000
otal Brook Trout			—	13,186

eeded management plan to make timum use of the potential sport and mmercial fish production.

In view of the deplorable conditions isting generally over the watersheds Haldimand County, including the butaries of the Grand River, a basic ver valley restoration program is sential before any significant fisheries anagement plan can be considered. n extensive water and soil con- rvation project is required for aldimand County if ground and surface waters are to become a more significant asset to agriculture, urban development, recreation, and the general economy and welfare of the county. The use of the discharge water from the Nanticoke hydro electric generating plant should be given serious consideration in developing a water management plan for western Haldimand County and perhaps the eastern limits of Norfolk County.

10) Farm pond and reservoir development should be further stimulated within the Haldimand-Norfolk region in order to provide aquatic environments in agricultural areas which can serve agriculture while providing the opportunity for aquatic recreation, esthetic, wildlife and economic benefits, and private and commercial fish production.

11) In view of the extensive use of the shoal areas of Lake Erie fronting Haldimand County by major sport and commercial fishes for reproduction and growth, it is essential that no effluents be discharged into the littoral zone of the lake which differ thermally or are of inferior quality to that of the local Lake Erie water.

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Introduction

The wildlife resources of the Haldimand-Norfolk area have been recognized as an important esthetic, recreational, and economic component of the environment since the beginning of recorded history.

The unique Carolinian-Alleghanian biota of Long Point and adjacent marshes is of major interest to naturalists and scientists, while the Lake Erie marshes of Norfolk County and the Grand River estuary of Haldimand County are major resting areas for migratory waterfowl and provide substantial fall hunting. Also, fur production from these areas is exceptional. Most of the marsh areas, however, are under private ownership and unavailable for public use.

Because of the mixed land use practices within the region, including substantial areas of woodlots, wetlands and idle lands, the terrestrial fauna is typical of southern Ontario with a relative abundance of several species of upland game and furbearers, and some local waterfowl production. Despite extensive areas of undeveloped land scattered through the agricultural watersheds of the region, there is no guarantee that these lands will not be directly, or indirectly, affected by present and future rural and urban development. Further, public access for naturalist and hunting purposes, and for general outdoor recreation, is being gradually diminished through the posting of these areas against trespass.

An integrated wildlife management plan is undoubtedly an immediate necessity for the Haldimand-Norfolk area if tracts of land and water are to be held and developed for the use and production of wildlife and the fauna of the region preserved for the benefit of present and future generations. The needs of society for outdoor recreation and open spaces in natural or semi-natural condition must not be ignored in the formulation of a regional plan for Haldimand, Norfolk, and neighboring counties.

This chapter appraises the present status of wildlife within the Haldimand-Norfolk region and proposes steps which must be taken to guarantee the perpetuation and enhancement of these valuable resources in the development of a regional plan.

Wildlife in Haldimand County

Haldimand County has a diversity of land use with productive farmland interspersed by extensive areas of submarginal and underdeveloped land (deciduous bush, lowlands, marshes) and, therefore, sustains those species of wildlife typical of southwestern Ontario. Consequently, hunters and trappers make significant use of these renewable resources.

Furbearers

Furbearers are harvested primarily from the Grand River and its tributaries with but a small proportion of the fur taken from the smaller watersheds. In 1968 (the most recent records available), there were 103 licenced trappers who harvested 11,700 muskrat, 75 mink and five red fox. The production of muskrat from the lower Grand River and its marshes is excellent. Further, the "Haldimand muskrat" are prime pelts and bring a premium price on the fur market. Beaver are scarce in the county but the low harvest of red fox and absence of raccoon in trappers' harvests reflect the low market value of pelts rather than a scarcity of the species.

Upland Game

The red fox is presently at a population level approaching peak abundance and provides hunting all over the county, reaching the greatest density in the more westerly townships. A few brush wolves perhaps ten to 12 annually, are shot, largely in the townships of Walpole, Rainham, and South Cayuga. Bounties paid to hunters over the past four years have averaged 302 for fox and five for brush wolves. The density of these species in the county has been estimated by the Ontario Department of Lands and Forests in 1967 at 0.4 fox and 0.1 brush wolf per square mile.

The raccoon is widely distributed and abundant in the county where it is presently of negligible value to the trapper but of considerable interest to the specialized hunter. In 1968, some 35 licenced raccoon hunters shot over 1000 animals.

The white-tailed deer is generally distributed at low density over Haldimand County, except in the southwest

(particularly Moulton Township) where there is a winter concentration of deer, presently estimated at about 150 animals (0.27 per square mile). In spite of the absence of a recent deer season, there is no appreciable build-up of the population while crop damage would seem negligible. Road kills average about 15 annually.

The cottontail is distributed throughout the district and is readily available to hunters in any locations offering suitable cover. The European hare is also relatively abundant, particularly in the western part of the county where it provides some hunting.

The grouse provides significant fall hunting for sportsmen, especially in the vicinity of Highway 3 (particularly northern parts of North Cayuga and Canborough and southern parts of Oneida and Seneca Townships). The woodcock provides sporadic seasonal hunting along most water courses where there is suitable cover. Areas of seasonal concentration include the lower Grand River, most grouse areas with water, and in the small watersheds along the Lake Erie shore in Walpole, Rainham, and South Cayuga Townships. As township licences are not required to hunt these species, the number of hunters using the county is not known but may be considered moderate.

Hunting for pheasants, rabbits, and fox in Haldimand County is controlled by the Regulated Township Licencing System. In 1968, some 1895 licences were sold for pheasant hunting and an additional 708 licences for general winter hunting after the pheasant season. The breakdown of licence sales for 1968 is shown in Table 9-1.

The exotic pheasant is self-sustaining to the extent that a few birds are living in the immediate vicinity of towns and villages where natural foods are supplemented by garden produce and, in some instances, by artificial winter feeding by local residents. By and large, the fall hunt is provided by the modest recovery of released hatchery-reared birds, by about 2000 hunters (1900 in 1968). The better hunting is found near cornfields. All townships but Seneca have a pheasant release program.

Table 9-1/Hunting Licences Issued in Haldimand County (1968)

Township	No. of Licences	Acres per Licence
Canborough	205	106
N. Cayuga	371	90
S. Cayuga	94	141
Dunn	245	60
Moulton	396	66
Oneida	246	136
Rainham	348	73
Seneca	263	156
Sherbrooke	63	79
Walpole	372	18
Total	2603	108 (av.)

The exotic Hungarian partridge is also self-sustaining within the county on a very modest basis. Distribution is limited generally to several coveys located in open land in the townships of Walpole, Rainham, and Seneca. Very limited hunting is provided for the specialized hunter.

In spite of the extent of non-cultivated lands offering favorable wildlife areas for the use of hunters and naturalists, the ever-increasing posting of private land against trespass is significantly restricting the use of these areas for outdoor recreation.

Waterfowl

Waterfowl are a significant wildlife resource in parts of Haldimand County, particularly the Grand River system and along the shoreline fronting Lake Erie. While the majority of ducks and geese frequenting these areas in the spring and autumn are migrating birds, a local production of ducks, primarily blacks, mallards and teal, which nest in the wetlands, provide early fall hunting each year before the arrival of northern birds. The Grand River marshes and wetlands sustain a variety of shore and marsh birds of ecological importance and local esthetic value.

The Grand River and its larger marshes provide a major resting area for migrating game and protected waterfowl during both spring and autumn months and, therefore, contribute to the welfare and maintenance of North American bird populations while, at the same time, being of considerable esthetic interest to naturalists and others. The autumn migration provides, as well, excellent hunting not only along the Grand River and its marshes but also along the open Lake Erie shoreline of Haldimand County. A few Canada geese appear during migration as do other migrating waterfowl including the whistling swan. The international importance of the Lake Erie marshes is stressed in the section of this chapter dealing with the Long Point marshes.

Some migratory waterfowl remain in open water in the Grand River and along the lake shore throughout the winter. Species noted during mid-winter inventories include mallard, scaup, old squaw, redhead, canvasback, goldeneye, buffle-head, and merganser.

The esthetic and sport value of waterfowl in the Grand River valley of Haldimand County is substantial and the contribution to outdoor recreation could be enhanced with the initiation of a waterfowl management program. The large estuarial marsh below Dunnville and to a lesser extent several smaller marshes upriver, offer excellent potential for the adoption of management practices.

Land along the Grand River and a mixture of agricultural and submarginal land, wetlands, and large deciduous woodlots, belonging to the Six Nations Indians, provides excellent habitat for wildlife. There is a good potential for effective wildlife management on the reserve and the development of controlled hunting areas for pheasant, waterfowl, and upland game should not be overlooked as a realistic source of income for the reserve.

Wildlife in Norfolk County

Norfolk County offers a variety of good habitats for wildlife although the preservation or development of lands for wildlife production has not been a consideration in past or present agricultural or forestry practices. Privately owned marshes fronting the lakeshore, however, have been manipulated for fur and waterfowl production for many years. Long Point, largely in private ownership, continues to be a natural refuge for wildlife with but modest exploitation of its wildlife potential.

Figure 9-1/Pond serving agriculture, wildlife, esthetic and recreational uses.

Furbearers

Harvests of furbearers by about 60 licenced trappers in 1968 included over 3000 muskrat, over 400 raccoon, nearly 200 mink, 12 fox and seven beaver. Principal trapping areas are the Lake Erie private marshes, river banks, and agricultural drainage ditches. In addition, bounties were paid on an average of 215 foxes and 9 brush wolves annually over the past four years.

Upland Game

Deer are widely distributed in the county but are not generally abundant except on Long Point where a local overpopulation has overbrowsed vegetation necessary for deer nutrition, forest regeneration, and soil stabilization. Annual deer population estimates for Norfolk County indicate a decline in numbers, estimated at 154 deer (0.24 per square mile) in 1968. There is no open season for white-tailed deer in Norfolk County.

The grouse is distributed widely in the many mixed woodlots dispersed through agricultural areas, and in the wooded ravines and gulleys of all watersheds. Because of the abundance of water, the woodcock is frequently present in most of the better grouse areas. Both species, particularly the grouse, provide abundant fall hunting. Vacant land, except for that belonging to the Big Creek Conservation Authority and the private Lake Erie marshes and Long Point, is not usually posted against hunting so that, at present, there are still excellent areas available for high quality public hunting.

All townships in Norfolk County participate in the Regulated Township licencing system which requires a special licence for hunting pheasants and cottontails. The latter species is the primary animal providing winter hunting although European hare are locally available. Regulated Township Licences issued in Norfolk County are shown in Table 9-2.

As township licences are not required for grouse, woodcock, or waterfowl hunting, the number of hunters using Norfolk County is not known but is certainly substantial.

The ring-necked pheasant is locally self-sustaining in comparatively low numbers, primarily in the vicinity of towns and villages and a few ravines along the Lake Erie shore including Long Point. Hatchery-reared pheasants are released annually under township auspices and provide for an open hunting season. The return of released birds is low with the best hunting associated with cornfields, market gardens, and ravines. Two private game farms in the county offer pheasant hunting for a fee and operate their own release system. Many farm ponds are attractive to wildlife (Figure 9-1).

Table 9-2/Hunting Licences Issued in Norfolk County.

Township	No. of Licences	Acres per Licence
Charlotteville	527	110
Houghton	39	400
Middleton	119	108
Townsend	347	139
S. Walsingham	80	247
N. Walsingham	168	206
Windham	375	114
Woodhouse	222	93
Total	2796	140 (av.)

Waterfowl

Waterfowl are a most important resource of the Lake Erie marshes fronting Norfolk County. The significance of the Long Point Bay marshes to international waterfowl management as well as to the people of southern Ontario cannot be over emphasized. These marshes serve as major resting grounds for the spring and autumn migrations of ducks, geese, swans, and a variety of other shore and water birds. Thousands of ducks of many species use these marshes each

autumn and provide excellent hunting as well as an unexcelled viewing experience for naturalists.

One of the most extensive fall and early winter concentrations of redhead and canvasback duck occur in Long Point Bay which is particularly significant in view of present international concern over the welfare of these species in the face of declining North American habitats. Similarly, the spring stopover of thousands of whistling swans offers a unique viewing experience and, consequently, attracts many people each year.

There is limited local breeding of ducks, particularly mallards and blacks, in wetlands, potholes, and small marshes scattered throughout the county. These provide local hunting particularly early in the open hunting season. Two of the more important inland waterfowl hunting areas are Lake Hunger (Windham Township) and the Waterford Ponds (Townsend Township). Major fall concentrations of migrating waterfowl which offer good hunting occur on Inner Long Point Bay, open areas in the Lake Erie marshes, and, on calm days, virtually along the entire Norfolk waterfront. Grain (stubble) fields in the southern part of the county attract flocks of ducks, and occasionally geese, and thereby provide some inland hunting.

Because of the private ownership of most of the Lake Erie marshes and shoreline, public waterfowl hunting is very restricted. Private floating blinds in Inner Long Point Bay and off Turkey Point are available for lease. Also, the Ontario Department of Lands and Forests rents blinds within a controlled public hunting area on Long Point where, in 1967, some 2451 hunters were accommodated.

Waterfowl species shot in the Lake Erie marshes and Long Point Bay include mallard, black, gadwall, pintail, green-wing and blue-wing teal, widgeon, shoveler, wood duck, redhead, ring-necked, canvasback, scaup, golden-eye, bufflehead, old squaw, scoter, ruddy duck, merganser, coot, and Canada, Brant, and blue geese.

Long Point and Marshes

Outer Long Point, remaining in private ownership with rigidly controlled access, has been preserved in a more or less natural state and supports a unique faunal and floral community within a transitional ecosystem lying between the Alleghany and Carolinian life zones.[1] In addition to the bio-geographical features of the Point, the geological formation is of significance.[2] The Point and its marshes are of major educational and scientific value.

Proposed Land Acquisitions for Fisheries and Wildlife Management

H-1
Walpole Township. This is an abandoned quarry with some open land to the west. It is presently used by migratory waterfowl, including swans. There is a potential for waterfowl resting and breeding areas, warm water fishing, and general esthetics.

H-2
Oneida Township. This is a mixed deciduous stand which presently provides good hunting (grouse, cottontail, squirrel, etc.) and has good potential for game management.

H-3
Oneida and North Cayuga Townships. This is an excellent marsh, lowland and deciduous bush area which presently offers some waterfowl and good mixed hunting. Potential is for waterfowl and upland game management.

H-4
Oneida and North Cayuga Townships. This tract consists of marshland, deciduous bush, and open land near the Mill Creek Conservation Authority Park and includes Mill Creek and the Grand River. There is an excellent potential for fish and wildlife management.

H-5
Seneca and North Cayuga Townships. This area of mixed deciduous bush and some wetlands currently provides good mixed hunting. Potential is for game management area.

H-6
Seneca Township. A tract of mixed deciduous bush and wetlands which presently provides good waterfowl, woodcock, and mixed upland game hunting. Potential is for waterfowl and upland game management.

H-7
South Cayuga Township. An excellent small marsh on the Grand River which presently provides waterfowl hunting and a fur harvest. There is an excellent potential for waterfowl and fur management area.

Summary and Recommendations

H-8
Dunn, Sherbrooke, and Moulton Townships. An extensive marsh traversed by the Grand River which presently provides a substantial waterfowl and fur production. An excellent potential is offered for a waterfowl and fur management unit with esthetic values.

N-1
North Walsingham. This tract includes several miles of Big Creek flowing through a mixture of deciduous bush and open lands. There is an excellent potential for fish and game management and general outdoor recreation.

N-2
Charlotteville Township. This tract includes the headwaters of Young Creek and encompasses an area of mixed woods and open lands. An excellent potential is offered for fish and game management and general outdoor recreation.

I-3
ong Point and Lake Erie marshes ronting Norfolk County. This area has xcellent potential for a comprehensive ntegrated wildlife management plan, ncluding fishing and hunting, aquatic ecreation, parkland, and general sthetics.

-4
his tract includes the headwaters of anticoke Creek (Townsend Township) nd the Waterford ponds. There is a ood potential for waterfowl, fish and ame management.

-1
iddleton Township (and Bayham and alahide Townships, Elgin County). his area comprises the Big and Little tter Creeks characterized by deep lleys and a rough topography, and vered by mixed deciduous woods and en lands. It offers an outstanding tential for intensive cold water fish d wildlife management, park land, and neral esthetics.

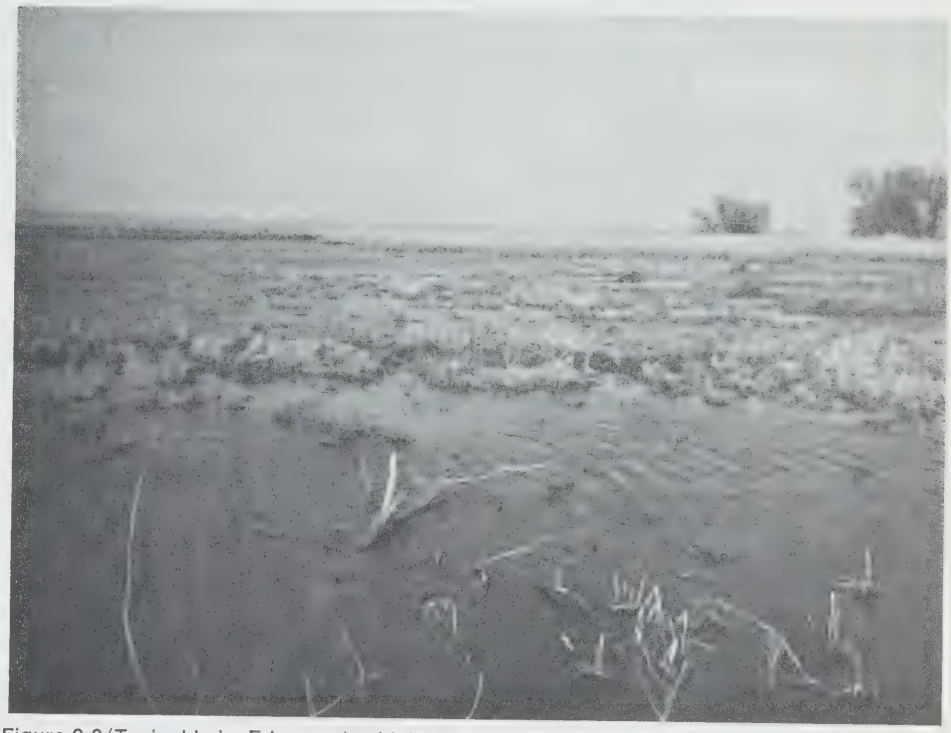

Figure 9-2/Typical Lake Erie marsh which attracts migratory waterfowl, provides hunting and sanctuary; sustains a variety of wildlife species and produces high quality furbearers.

Summary

Favorable *terrestrial wildlife* habitats are dispersed throughout the agricultural lands of Haldimand and Norfolk and adjacent counties. The presence of numerous large mixed deciduous woodlots, wooded and open river valleys, wetlands, and non-cultivated marginal farmland provide a variety of environments for substantial self-sustaining populations of grouse, cottontail, European hare, fox, squirrel, and most fauna typical of southern Ontario. Woodcock are locally abundant in many grouse habitats. Hungarian partridge are self-sustaining at a low level in isolated coveys. While there are naturalized populations of ring-necked pheasants, hatchery-reared birds are released for hunting under the Regulated Township Licencing System.

The annual harvest of furbearers in 1968-69 totalled over 18,000 pelts with a value to the trapper of over $30,000, indicating the abundance and use of the resource (see Chapter 8, Tables 8-4 and 8-5). In addition, the quality of upland game hunting is reflected in the sale of 5349 township licences. As provincial gun licences are required only for hunting waterfowl and animals not requiring a township hunting licence, the actual number of hunters using the abundant wildlife resources of the region is not known. Revenue from the sale of all local licences and permits for hunting and fishing in the region in 1969 (7220) was $27,097. (Chapter 8, Table 8-4.)

Because of the relatively low rural human population and the presence of numerous tracts of "idle" land in both counties, the quality and availability of mixed hunting may be considered excellent. Hunting pressure on upland game is not excessive. The practice of posting private lands against trespass is becoming prevalent in Haldimand County and, if the trend continues, the problem of public hunting will become acute within a very few years.

An abundance of *aquatic wildlife* inhabit the extensive Lake Erie marshes fronting Norfolk and Haldimand Counties (*i.e.*, the Grand River, Turkey Point, Big Creek, and Long Point marshes). These marshes provide vital habitat for local waterfowl, shorebirds, and furbearers,

while serving as major resting areas for migratory waterfowl (Figure 9-2). Further encroachment of agricultural, urban, or industrial development on these marshes must be prevented. Rather, the potential of these marshes for wildlife production and public use (including birdwatching and hunting) must be developed through an integrated wildlife management plan incorporating public lands and privately owned lands which should be acquired. Present hunter use of the Long Point Waterfowl Area, and the pilgrimages of many naturalists to watch flights of whistling swan, redhead and canvasback duck, and other resident and migrant birds, attests to the present and potential interest in these marshes.

Long Point in Norfolk County, because of its unique Carolinian-Alleghanian life zone, is of major ecological significance and every effort must be taken to ensure the perpetuation of the floral-faunal communities of its sand and marsh areas. A sound management plan for Long Point is imperative if the potential biological, geological, geographical, educational, and esthetic attributes are to be fully realized for public benefit.

Recommendations

1) In view of the present abundance and potential production of upland game and waterfowl within the Haldimand-Norfolk region, it is essential that an integrated wildlife management plan be developed before the continuing alteration of the terrestrial and aquatic environment by other interests further destroys those ecosystems essential for the great variety of native, resident, and migratory fauna which still occupy all available habitats. It is recommended that intensive wildlife management (including fisheries and multiple use, where feasible) be initiated on selected tracts of land which must be acquired for this purpose through purchase or other arrangements with private landowners. Areas which must be acquired immediately, or held from untoward development, include the Long Point Bay and Grand River marshes, all river valleys and water courses, gulleys, and areas of wooded and open lands which, collectively, offer a diversity of wildlife habitats with high potentials for wildlife production and use (see Map 9-1). These wildlife management areas will, as well, have a major esthetic value in providing necessary greenbelts and open spaces with floral and faunal significance.

2) In view of the detrimental and permanent effects of agriculture, residential, and industrial encroachment on the scenic and faunally rich valleys of Norfolk County, it is essential that no-development belts be established along all water courses as a general conservation practice, such belts to be managed for wildlife production, public hunting and fishing, and general esthetic and recreational purposes.

3) Steps must be taken immediately to preserve in perpetuity the unique flora, faunal and ecological features of the Long Point and Lake Erie marshes, all of Long Point, and adjacent farmland and shoreline fronting Norfolk County. Here priority should be given to the early realization of a comprehensive management plan to include wilderness areas, sanctuaries, waterfowl breeding and resting areas, spawning grounds for warmwater fish, and public hunting for ducks, geese, pheasants, woodcock, and upland game species.

4) Immediate action must be taken to review the present government policies relating to the drainage of wetlands and the destruction of fence rows, both practices being presently subsidized by public funds but grossly detrimental to fish and wildlife. Practices of land use must be established which recognize the sound principles of multiple land use.

5) Steps must be taken immediately to review government policy relevent to irrigation and the withdrawal of water from streams, including the mutilation of stream beds by the construction of water holding ponds within the watercourse. These agricultural practices in cash crop areas of Norfolk County, in particular, are totally inconsistent with fisheries management or good watershed management.

6) Immediate action must be taken to prevent further Industrial encroachment on the estuarial marsh of the Grand River (between Dunnville and Port Maitland) through government acquisition for migratory waterfowl and fur production in view of the high potential of the area for effective wildlife management.

7) It is strongly recommended that an intensive and extensive investigation be initiated at the earliest possible moment on the uses of agricultural chemicals in Norfolk County and on the nature of Industrial effluents throughout the region in view of the great danger to wildlife species. Further, these studies must appraise present chemical residue levels in wildlife with respect both to the welfare of the species and the threat to human health.

Footnotes/References

Footnotes

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aluable details on the wildlife resources of e Haldimand-Norfolk region were ovided by:
r. C. H. D. Clarke, and F. Waldon, D. Simpkin id R. Thomasson of the Ontario Department Lands and Forests; W. Clarke, D. Johnston, . Mackenzie, C. Pell, and conservation ficers of the Lake Erie District; and Mansell, E. Meadows, and conservation ficers of the Lake Huron District of the ntario Department of Lands and Forests; Van Wesenbeeck and staff of the Big eek Conservation Authority; and D. Coutts d N. Oldfield of the Grand River nservation Authority.

Introduction

All waters within the Haldimand-Norfolk Study Area have been greatly modified from their pristine condition by the processes of human settlement which have disregarded and continue to disregard, accepted principles of wise land and water use. Technological developments of the past quarter century, coupled with but a modest rise in human population, have increased the rate of environmental deterioration through agricultural, industrial, and domestic pollution. Present water conditions in many areas exclude or threaten the existence of lower aquatic life essential for the natural purification of water and the maintenance of environmental quality, endanger existing fish and wildlife species, destroy esthetic resources, and imperil human welfare and health.

This appraisal of the Study Area, therefore, cannot do other than focus attention on the present unsatisfactory and often appalling conditions within the aquatic environment and point out essential remedial action which must be undertaken before any further industrial or urban development should be considered. Because of the general differences in water quality problems between Norfolk and Haldimand Counties, observations on the watersheds of the two counties will be dealt with separately. However, the whole area is considered as a unit in the discussion and recommendation sections.

Watersheds of Haldimand County

Table 10-1/Chemical Analyses of Water Samples Collected from the Grand River in June, 1966.*

Station	BOD	Solids		Free Ammonia	Total Kjeldahl	Total Phosphorus
		susp.	diss.			
G20 above Brantford	4.4	10	4.5	0.13	0.65	0.82
G22 below Brantford	4 4	37	419	0.39	1.30	1.80
G26 above Caledonia	2.6	33	437	0.33	1.20	1.10
G27 below Caledonia	3.8	32	418	0.30	1.20	1.22
G29 below Cayuga	3.2	35	471	0.02	1.30	1.16
G30 below Dunnville	3.6	32	500	0.36	1.15	0.72

*Extracted from German, M. J., 1967. *Biological survey of the Grand River and its tributaries.* Publ. Ontario Water Resources Commission: Table 12.

Table 10-2/Annual Variations in Selected Pollution Indicators in the Lower Grand River from mid-August, 1967 to September 1, 1968.*

		Grand River Station Near Brant-Haldimand County Line	Grand River Station Near Caledonia
Copper	maximum	0.017	0.014
mg/1	minimum	0	0
	mean	0.004	0.003
Hexavalent	maximum	0.008	0.003
Chromium	minimum	0	0
mg/1	mean	trace	trace
Fluoride	maximum	0.44	0.51
mg/1	minimum	0.11	0.10
	mean	0.26	0.29
BOD (5-day)	maximum	12.6	12.2
mg/1	minimum	2.0	2.4
	mean	6.6	6.1
NPN	maximum	9200	9200
coliforms	minimum	1600	240
per 100 ml	mean	5260	3420
Synthetic	maximum	1.18	1.11
detergents	minimum	0.15	0.15
mg/1	mean	0.46	0.45

*Data extracted from Kelso, John R. M., 1969. *Seasonal and diel changes in selected properties of river water.* M.Sc. thesis, University of Guelph.

Water quality and flow characteristics of the watersheds of Haldimand County are the unfortunate result of the general geological and topographical features and land use patterns of the area. Evident is the inadequacy and misuse of available natural surface waters and the general absence of a watershed management plan. Agricultural practices generally ignore accepted principles of soil conservation and erosion control. No serious attempt has been made at flood control or water management through reservoir con-

able 10-3/Coliform Counts Recorded from Stations on the Grand River during 1969.*

ate	Coliform Counts per 100 ml											
	Port Maitland		Dunnville		Cayuga		York		Caledonia (below town)		Caledonia (above town)	
	T.L.	F.L.	T.L.	F.L.	T.L.	F.L.	T.L.	F.L.	T.L.	F.L.	T.L.	F.L.
; July	12000	130	16000	6	3850	56	17000	3200	80000+	750	80000+	190
; July	36000	270	36000	39	35000	1850	950	165	24000	370	—	—

)ata extracted from material provided by the Norfolk-Haldimand Health Unit.

able 10-4/Seasonal Variations and Means in Water Quality of Watersheds in Haldimand-Norfolk Region.

ater	Coliforms /100 ml	Dissolved Oxygen	5-Day BOD	Total Suspended Solids	Turbidity Units	Total Phosphorous	Total Kjel Nitrogen
and River mile 0.4 /. of both les river)	3955 (112-101000)	9.4 (2.0-13.0)	3.2 (0.6-6.5)	409 (236-594)	18.7 (1.7-33.0)	0.29 (0.3-2.8)	1.29 (0.75-2.40)
and River mile 10.8 ıd of road Canfield nction)	215 (48-470)	8.2 (3.2-14.0)	4.0 (2.6-7.0)	451 (310-534)	31.5 (12.0-58.0)	0.24 (0.14-0.45)	1.28 (0.8-2.4)
nfish Creek butary of and River Dunnville)	3967500 (80000-10000000)	2.9 (0.00-6.0)	165 (28-800)	1262 (508-1602)	52.5 (16-116)	3.74 (0.8-9.4)	21.7 (3.6-1.0)
neca Creek butary of and River Caledonia)	956 (92-2200)	7.4 (6.0-9.0)	1.8 (1.4-2.0)	1550 (620-2700)	12.6 (6.0-20.0)	0.13 (0.08-0.21)	0.89 (0.25-1.60)
ney Creek nile 1.0 inham Twp.)	25250 (22-140000)	7.5 (2.0-11.0)	2.2 (0.6-3.0)	460 (222-798)	19.3 (1.8-52.0)	0.22 (0.10-0.50)	1.06 (0.77-1.30)
ndusk Creek nile 0.6 alpole Twp.)	328 (16-28000)	7.5 (6.0-9.0)	2.7 (1.0-5.0)	365 (278-450)	30.3 (5.0-82.0)	0.13 (0.05-0.20)	1.00 (0.59-0.78)
nticoke Creek nile 1.0 alpole Twp.)	3341 (80-18000)	7.8 (5.0-0.0)	3.0 (1.2-4.8)	444 (334-564)	52.1 (12.0-220.0)	0.18 (0.05-0.70)	0.98 (0.55-2.00)
n River nile 5.6	5700 (460-33000)	9.9 (8.0-11.0)	2.7 (1.0-4.4)	360 (342-370)	8.6 (2.0-27.0)	0.39 (0.13-0.88)	0.62 (0.42-0.86)
drick Creek nile 0.6 Walsingham wnship)	307 (70-12000)	8.3 (6.0-10.0)	1.7 (0.4-3.2)	283 (236-336)	20.0 (6.0-28.0)	0.06 (0.07-0.11)	0.45 (0.27-0.62)
Creek nile 0.2 ghway 59)	936 (32-6000)	8.5 (6.0-9.5)	1.8 (1.2-2.6)	345 (310-394)	10.7 (3.8-20.0)	0.05 (0.3-0.7)	0.52 (0.39-0.65)
ar Creek nile 0.5 ughton Twp.)	3761 (12-22000)	8.2 (7.0-10.5)	1.8 (0.6-3.2)	309 (272-350)	14.0 (2.3-40.0)	0.06 (0.02-0.12)	0.65 (0.30-1.45)

ummary of preliminary data provided by the Ontario Water Resources Commission from monthly analyses, January to September, 1970.

sfiction and other techniques. Further, reforestation and land rehabilitation practices which would enhance existing water quality are negligible.

Grand River Watershed

The Grand River, being the only major flowing system in Haldimand County, is of very great importance for multiple use which includes water supply, receiving sewage wastes and runoff, providing waterfowl habitat and fur production areas, supporting sport and commercial fisheries and aquatic sports, and general esthetics. Water quality, there-

fore, must be a prime consideration.

The water quality of the Grand River, on entering Haldimand County from the north, may be defined as polluted by accepted standards (Tables 10-1 and 10-2). Enrichment is pronounced and bacterial levels reach a dangerous level. High levels of suspended and dissolved solids, ammonia, nitrogen, and phosphorus may be attributed to effluents entering the river from the city of Brantford, although significant pollution does occur further upriver. While some natural repurification occurs downriver, the addition of pollutants from all the major towns does not allow any appreciable recovery in water quality. The hamlets of York, Mount Healey, and Deans have no community services for water supply or waste treatment but, at present population levels, have no significant influence on the quality of Grand River water. Caledonia, Cayuga, Dunnville, and Port Maitland all contribute substantially to the impaired quality of river water.

Bacterial counts in the lower Grand River vary greatly during the year but reach peak levels during the summer months (Tables 10-3 and 10-4). High coliform levels present a serious danger to public health; in 1969 part of the river had to be closed to swimming. The compelling need for more efficient sewage treatment by existing plants at Brantford and Caledonia is obvious. The installation of new plants at Cayuga, Dunnville, and Port Maitland capable of coping with organic and nutrient loads is imperative. The effectiveness of the large lagoon system serving local industries at Port Maitland is questionable.

Tributaries of the Grand River entering in Haldimand County drain wetlands and valleys in which conservation practices are not evident. Their overall contribution to the Grand River is one of variable flow, silt load, some eutrophication, and variable bacterial contamination (Table 10-4). Sunfish Creek at Dunnville is most heavily polluted.

Two tributaries serve useful purposes. Mill Creek, once a borderline trout stream, is newly impounded by the Grand River Conservation Authority and provides a small center for recreation and warmwater fishing. Mackenzie Creek, although turbid and badly silted, provides the domestic water supply for the community of Ohsweken (Brant County). Big, Fairchild, and Boston Creeks originate in Brant County where they pass through agricultural and submarginal lands, and wetlands before and after reaching Haldimand County. All are turbid, warm in summer with variable and intermittent flow.

Table 10-5/Chlorinated Hydrocarbon Residues in Tissues of Fish Collected from the Grand River Below Caledonia During 1967 and 1968.*

Sampling Date	Tissue	Chlorinated Hydrocarbons (ppm)					
		DDE	opDDT	DDD	ppDDT	DDT	Dieldrin
July 1967	L	0.042	0.022	0.271	0.031	0.367	—
	G	0.026	0.023	0.265	0.033	0.347	—
	DM	0.021	0.014	0.052	0.023	0.110	—
	VM	0.121	0.055	0.311	0.109	0.597	—
November 1967	L	0.222	0.289	0.714	0.353	1.578	0.221
	G	0.170	0.260	0.581	0.212	1.223	0.165
	DM	0.132	0.279	0.550	0.345	1.306	0.241
	VM	0.177	0.262	0.613	0.322	1.374	0.185
May 1968	L	0.120	0.139	0.189	0.109	0.557	0.738
	G	0.105	0.139	0.167	0.105	0.516	0.015
	DM	0.044	0.119	0.100	0.113	0.376	—
	VM	0.099	0.115	0.173	0.155	0.542	0.018
November 1968	L	1.182	1.055	1.882	0.590	4.709	0.108
	G	0.242	0.227	0.508	0.185	1.212	0.069
	DM	0.121	0.086	0.280	0.085	0.572	0.009
	VM	0.221	0.214	0.587	0.247	1.269	0.014

L — liver; G — gills; DM — dorsal muscle; VM — ventral muscle.

*Data extracted from Kelso, John R. M., 1969. *Seasonal and diel changes in selected properties of river water.* M.Sc. thesis, University of Guelph.

The main Grand River in Haldimand County is perpetually turbid and organically overloaded throughout, despite a comparatively low human population density and the absence of large industry, except at Port Maitland. The extent and influence of industry upriver has not been determined although trace levels of heavy metal suggest an industrial source (Table 10-2).

Pesticide levels in fish are low in comparison to samples from many other waters (Table 10-5). After extensive analyses of commercial fish by government agencies, mercury residues are not considered a threat to human health and the commercial fishery was allowed to continue to market food fish from the lower river, estuary, and adjacent to Lake Erie. No odors or tastes are apparent in locally harvested fish, nor are muskrat pelts adversely affected by oils or other chemicals. The presence of a variety of warmwater fishes (German, M. J., 1969; unpublished data, University of Guelph) indicates that chemical pollution, except possibly at the mouth, is not serious.

The appearance and substandard quality of the Grand River has resulted in a public reluctance to make more than modest use of the recreation potential of the river and its banks. Interest in angling is curtailed because of the suspicion with which the quality of fish flesh is held, although commercial fishermen had no problem in disposing of their product within the industry prior to the 1970 heavy metal problem elsewhere in the Great Lakes.

Obviously more effective controls in and upriver from Haldimand County on water pollution are imperative if the Grand River is to be restored to an acceptable standard of water quality. Already overloaded, the river's condition can only be aggravated by any urban or industrial expansion, increasing

the present levels of pollution and degrading the aquatic environment to the exclusion of its present fish, wildlife, recreational, and esthetic uses.

Small Watersheds in Haldimand County
Small watersheds in Haldimand County are similar in their pattern of widely variable and frequently intermittent flow. All are extremely turbid, warm up greatly during the summer months when, during periods of drought, only stagnant pools may exist. All are subject to extensive flooding which causes bank erosion and carries silt loads into Lake Erie. Even Nanticoke Creek, the largest watershed beginning in Brant County, may cease to flow although it supports a minimum warmwater coarse fish fishery.

Water Quality Assessment, Haldimand County

Surface water is inadequate to handle the present demands placed on it for human and farm uses in spite of sparse human settlement. In addition to those communities on the Grand River previously mentioned (*i.e.,* Caledonia and Cayuga with wells, Dunnville with Lake Erie water), only Jarvis and Hagersville have municipal water supplies drawing on groundwater. A settlement at Peacock Point draws on a private supply of lake water as does the industry at Port Maitland. All other communities are dependent on the private wells of residents supplemented by cisterns. Chemical peculiarities of the groundwater (*e.g.,* high sulphur) limit its usefulness.

Most communities have problems with sewage treatment and effluent discharge. At Jarvis, the lagoon system (effective in treating primary organics) connects with a small creek but, because of the limited flow, discharge from the lagoon can be made only during spring flooding. At Hagersville there is primary treatment and sewage is distributed on drying beds. The effluent is discharged into a small creek which may not flow during the summer months. In both Jarvis and Hagersville a population quota has been established pending a solution to the problem of waste treatment.

Most of the smaller communities, including Nanticoke, Selkirk and Fisherville lack both municipal water supplies and community sewage systems and have organic pollution problems because of a scarcity of water and poor soil porosity for septic tank effluents. Present water resources are grossly overloaded and must be remedied. The growth of population and new industrial development should be limited in the communities of Haldimand County until a satisfactory water supply and sewage plan for the entire Study Area is developed and until it is assured that the development will fit the plan.

Because of the present location of several garbage dumps on or near natural water courses in Haldimand County and, particularly in view of the flow characteristics of most local creeks, there exists a potential danger of the effects of leached organics and toxic wastes on humans, domestic animals, and other life existing downstream.

The provision of an adequate water supply is vital for the present welfare, and imperative for the growth, of most existing communities. The only exception probably is Dunnville which is now supplied with Lake Erie water althought without a sewage treatment system at time of writing. Soil conditions are proving inadequate to handle the septic tank requirements of even the smaller hamlets as well as shoreline park and cottage developments. If sewage and waste water are to be disposed of without continuing and increasing environmental degradation, substantial quantities of water must be made available to all communities regardless of size, coupled with a sewer network to treatment plants. Examples of the inadequacies of the smaller Haldimand stream systems to handle local organic loads are Stoney, Sandusk, and Nanticoke Creeks where bacterial counts reach dangerously high levels

Lake Erie Fronting Haldimand County

Table 10-6/Mid-depth Levels of Dissolved Oxygen and Total Phosphorus at 2 Stations in Lake Erie Fronting Haldimand County*

Station	Time									
	1000 hours		1200 hours		1500 hours		1700 hours		1900 hours	
	D.O. % sat.	PO_4 ppm	D.O. % sat.	PO_4 ppm	D.O. % sat.	PO_4 ppm	D.O. % sat.	PO_4 ppm	D.O. % sat.	PO_4 ppm
5004 (approx. half mile offshore)	87	0.10	96	0.11	100	0.12	101	0.05	97	0.04
	90	0.10	98	0.09	101	0.10	101	0.04	100	0.05
	96	0.12	95	0.09	99	0.07	100	0.04	100	0.04
501 (over two miles offshore)	98	0.10	97	0.08	97	0.06	99	0.05	98	0.05
	95	0.09	98	0.10	99	0.05	98	0.04	99	0.04
	97	0.09	96	0.10	97	0.05	98	0.04	99	0.03

*Extracted from table i, Palmer, M. D., 1968. Required density of water quality sampling stations at Nanticoke, Lake Erie. Publ. Ontario Water Resources Comm. August-September 8-9.

The open and onshore waters of Lake Erie fronting Haldimand County cannot be considered organically polluted if high levels of dissolved oxygen are used as a criterion (Table 10-6). Although heavy plankton blooms and flourishing growths of filamentous algae along the shore are visible evidence of enrichment, the water chemistry of onshore waters (Tables 10-6 and 10-7) does not indicate excessive eutrophication. Lake nutrient levels are very much lower than in the Grand River and tributaries. The high productivity of this area of Lake Erie is reflected in the abundance of warm-water sport and commercial fish.

Pollution levels along bathing beaches are an increasing concern from the standpoint of public health. Coliform counts vary seasonally and on some beaches fronting Haldimand County approach dangerous levels. The situation is bound to deteriorate further without remedial action.

Because of the extensive use of onshore waters for spawning by the more commercial fish (perch, smelt, etc.) and the major sport fish of the area (especially the smallmouth bass), any significant change in the thermal regime or quality of the onshore waters could have irreversibly adverse effects on these species.[1]

Table 10-7/Water Quality Criteria for Sampling Station in Lake Erie Approximately One-Half Mile Offshore from Nanticoke, Haldimand County*

Parameters	Concentration (ppm)
Suspended solids	16
Dissolved solids	196
Total solids	212
Iron	0.25
Tin	0.1
Zinc	0.0
Ether, soluble	1.0

*Extracted from Palmer, M.D., 1968. *Required density of water quality sampling stations at Nanticoke, Lake Erie.* Publ. Ontario Water Resources Comm. August-September:10.

No model for Lake Erie is yet available which validly predicts the effects of a large and continuous local withdrawal of littoral water on the limnology of the Walpole Township shoreline, and beyond.[2] Neither is there any valid prediction of the effect of the continuous return of a similar volume of heated (cooling) water or treated (domestic and industrial) effluents to the limnology (*i.e.*, density, current patterns, ambient temperature, etc.) of onshore water. Present water current studies indicate that effluents would be carried in a generally eastward direction over presently important fish spawning areas under natural conditions but natural current patterns may be modified by a continuous local withdrawal and return of high volume flow.

Also, the effects of winds, lake currents, and nutrients in combination with the continuous discharge of heated water may have serious local onshore biological implications associated with eutrophication and putrifaction. Possible unfavorable results include excessive algal blooms, odors, tastes, and BOD levels creating oxygen deficiencies which, especially at night, could be detrimental to necessary invertebrate life and cause fish die-offs. The extent of the area potentially affected cannot be predicted on the basis of current knowledge.

Present Water Use in Haldimand County

Present water use by municipalities in Haldimand County is shown in the following chart.

Smaller communities are dependent on private wells for raw water, and on individual septic tanks for sewage treatment. Because of soil type, even small villages have problems of soil and water pollution which can be remedied only by establishing community water works and sewage disposal systems. Several areas along the lake are serviced by privately owned water supplies which could be improved by a consolidated system.

Municipality	Population	Water Source	Sewage Disposal
Caledonia	2,900	drilled wells	Primary treatment; effluent discharge into Grand River
Cayuga	1,100	Grand River	In process of establishing initial sewage treatment plant
Dunnville	6,000	Lake Erie and Grand River	In process of installing initial sewage treatment plant
Hagersville	2,300	drilled wells	Primary treatment plant. Limited by inadequate stream flow for effluent
Jarvis	840	Lake Erie	Lagoon system limited in expansion due to limited stream flow for effluent
Ohsweken		Mackenzie Creek (Grand River)	

Norfolk County Watersheds

Problems of water quality in Norfolk County stem primarily from agricultural practices, predominantly, but not exclusively, tobacco farming. Three points stand out: first, the indiscriminant use of surface waters for irrigation; second, the encroachment of cultivated land on watercourses without regard for needed controls on runoff and soil erosion; and third, the heavy use of pesticides (including DDT) and fertilizers. The first two of these practices, totally detrimental to water quality locally and downriver, are especially pronounced in the headwaters of the Big Creek system in South Norwich (Oxford County) and in those feeder creeks along the Norfolk County watercourse which are not protected by wooded gulleys. The most significant effects of these agricultural practices are, first, grossly abnormal variability in flow with many creeks reduced to a trickle, or ceasing to flow entirely leaving natural and artificial stagnant pools used often for irrigation; second, very significant increases in summer water temperatures; and third, a general heavy bottom siltation of all waters in Norfolk County, even those which are otherwise of excellent quality, (Figure 10-1).

Few tributaries or main streams in Norfolk County are immune from irrigation practices but, fortunately, the abundant discharge of groundwater *(i.e.,* springs) into a number of water courses maintains substantial flows of cold and relatively clear water which provide a water quality and aquatic environment superior to that prevalent generally in the surrounding part of southwestern Ontario. The watersheds of Norfolk County (and the Otter Creek watershed largely in Elgin County) stand out as an oasis in a region of Ontario where surface waters are a critical resource.

Lynn River and Big Creek Watersheds

The lower reaches of the two main watersheds in Norfolk County (*i.e.,* the Lynn River and Big Creek) have similar ecological characteristics of extremes in seasonal flow and water temperature, turbidity, heavy siltation, and resident warmwater sport and coarse fish. Water

Figure 10-1a/Conflict in land and water uses. Trout stream with overhead cover and natural bank protection.

Figure 10-1b/Same trout stream subjected to ditching and encroachment of agriculture.

Table 10-8/Water Chemistry of Big Creek and 2 Major Tributaries (North Creek and Venison Creek) on 15 July, 1966.*

Watercourse	B.O.D. (5-day)	Solids total	susp.	diss.	Total PO_4	Free Ammonia	Total Kjel. (N)	pH
Big Creek								
above Delhi	1.0	304	1	303	0.01	0.10	1.10	8.4
below Delhi	2.0	236	9	227	0.3	0.05	1.3	8.4
near mouth	4.0	348	30	318	0.18	0.06	0.33	8.4
North Creek (trib. of Big Creek)	1.0	310	1	309	0.06	0.06	0.07	8.3
Venison Creek (trib. of Big Creek)								
near source	1.7	296	17	279	0.10	0.02	0.13	8.4
near mouth	0.8	258	11	247	0.10	0.02	0.20	8.5

*Extracted from data provided by the Ontario Water Resources Commission.

quality is poor with bacterial counts variable but reaching dangerous levels (Table 10-4). Rapid deterioration occurs as the Lynn River passes through Simcoe. Delhi has a similar, but less extreme effect on Big Creek. North and Venison Creek, tributaries of Big Creek, provide cold water for trout and are not appreciably polluted. The condition of lower Big Creek was very similar to that recorded during the summer of 1962.

Small Watersheds in Norfolk County

Several small watersheds flowing into Lake Erie (Forestville, Gibson, Patterson, and Young Creeks) provide cold water of favorable quality and good flow, and show no evidence of pollution by domestic or other effluents. All or parts of numerous headwaters and tributaries of the Big Creek and Lynn watersheds have similar favorable features. These include Venison, Deer, Silver, Trout, and North Creek (Big Creek system), and Patterson's Creek (Lynn River system).

By contrast, the Dedrick Creek and Big Creek watersheds are of poor quality with bacterial counts becoming dangerously high at times (Table 10-4). Virtually all streams in Norfolk County are heavily silted, primarily because of poor land use practices, so that natural reproduction of salmonid fishes is greatly impaired even in streams otherwise suitable. Also, most streams are subjected to excessive periodic withdrawal of water for irrigation.

Water Quality Assessment, Norfolk County

Organic and industrial pollution is limited to several localized situations within Norfolk County. Each of the 5 largest centers of population (Simcoe, Delhi, Port Dover, Waterford, and Port Rowan) have a history of significant water pollution and although all (with the exception of Port Rowan) have improved or new sewage treatment plants, impaired water quality is still evident in natural water courses within and below the towns. Because of the limited capacity of Nanticoke Creek to handle effluents, water quality downstream would not be expected to improve appreciably under present conditions. The extent of pollution at Port Dover and Port Rowan has undoubtedly been masked by the dilution of Lake Erie water but, even with the new treatment plant at Port Dover, both municipalities will continue to contribute to the local eutrophication of the Lake Erie shore. Already the storm ditch in a new Port Dover subdivision is carrying effluents to Lake Erie. The situation is critical at Port Rowan where the general enrichment of Inner Long Point Bay is a continuing matter of public concern.

Smaller communities (*e.g.*, Langtor typically dispose of sewage through private septic tanks and, because of the prevalence of sandy soils, there is generally no water quality problem except in odd instances (*e.g.*, at Courtland and Vittoria) where storm-sewers defile the water quality of local creeks. Of significance, also, is the effect of high Lake Erie water levels on the septic tank systems on the Long Point, Turkey Point and less developed beaches.

Local fish kills occur from time to time in waters of the county, usually because of the introduction of agricultural chemicals to the water (*e.g.*, while filling tanks, cleaning spray equipment, etc.). The main effect on aquatic resources has not been great. Pesticide levels in fish tissues have not been adequately sampled but available data suggests comparatively low levels in th Lake Erie region. Investigations by the Ontario Water Resources Commission 1966 concluded that "it is probable that fish and macroinvertebrate popu-

Lake Erie Fronting Norfolk County

lations in Big Creek, major tributaries, and Inner Long Point Bay have not been severely impaired as a result of pesticide use in the basin" although "pesticide use is probably significant with respect to the high frequency of farm pond fish kills in the area".

Water impairment from local garbage and refuse dumps is both a present and potential threat to the health of humans, domestic animals, and wildlife. Dumps are located on or near water courses; in some cases materials are put directly into the water. Aside from the problem of eutrophication, the release of toxic materials is a perpetual hazard to life.

There is visible biological evidence of eutrophication generally along the Lake Erie shoreline of Norfolk County. The shoreline fronting Houghton and South Walsingham Townships eastward to the tip of Long Point shows comparatively modest indication of eutrophication. This results from a combination of factors. Only one small watershed discharges into the lake here (Clear Creek). There is only negligible cottage and residential development and no industrial development; there are prevailing onshore winds and strong currents. Bacterial counts on the Long Point Beaches are variable and generally within acceptable limits although danger may exist in the future.

Eutrophication of Inner Long Point Bay is evident by the abundant aquatic vegetation. The bay is filling in rapidly with silt. Remarkable changes in vegetation patterns and sediment deposits have occurred within the memory of people still living. By accepted limnological criteria, the bay can be defined as enriched but not polluted except in the vicinity of Port Rowan where a stormsewer, likely carrying sewage and other wastes, discharges into the bay about half a mile from the municipal waterworks intake[3]. Both Dedrick and Big Creek have a history of poor water quality (Table 10-4). Difficulties may be expected in continuing to obtain potable water from the shallow Inner Bay to serve the village of Port Rowan, partly because of excessive algae and rooted aquatic weeds.

Sources of enrichment in Inner Long Point Bay are the village of Port Rowan, and the marina and cottage developments at St. Williams, Port Rowan, Causeway, and Long Point. Elimination of the Port Rowan source is feasible and immediately mandatory. High Lake Erie water levels may seriously impair the efficiency of septic tank systems, particularly on Long Point, by the flooding of tile beds. There is potential danger to public health and the canals serving cottages are esthetically unsuited for swimming. While the Big and Dedrick Creek systems bring in a nutrient load which is bound up seasonally in plant growth,[4] it is the silt load from the Big Creek drainage which is rapidly advancing the ecological aging of the Inner Bay.

At the present rate of siltation the Inner Bay will likely progress rapidly to a marsh environment unless countermeasures are taken now. Levels of aquatic vegetation are approaching the density that the probability of massive winter kills of fish under ice cover is a reality, particularly if lake water levels decline. Among countermeasures proposed are, first, the diversion of Big Creek to its former (and natural) outlet directly into the open lake; and, second, the dredging of a cut across Inner Bay Point joining the open lake with the Inner Bay, also a condition previously occurring naturally. These and possible alternative proposals merit serious and immediate consideration.

Water quality along the Charlotteville and Woodhouse Townships shoreline of Long Point Bay shows evidence of appreciable enrichment with the seasonal occurrence of dense plankton blooms and the general presence of filamentous algae in nuisance abundance. Bacterial counts along the various beaches vary seasonally and, during the summer of 1969, reached undesirable levels at Turkey Point, Port Ryerse, and Port Dover beaches. The closure of the shoreline to swimming may become necessary if more stringent controls on sewage and waste water disposal are not placed on existing shoreline settlements and parks, and on tributary watersheds.

Table 10-9/Examples of Pesticide Residues in Fish from Inner Long Point Bay and Lake Erie.

Location	Species	Date	No. of Fish	Tissue	ppDDE	ppDDD	opDDT	ppDDT	Total DDT
Inner Long Point Bay	smallmouth bass	1968	16	muscle	0.32	0.11	0.04	0.37	0.84 (0.32-4.28)
	pumpkinseed	1966	5	muscle	0.13				
	rockbass	1966	5	muscle	0.38				
	yellow perch	1967	6	muscle	0.11				
				gonad	1.90				
Lake Erie: eastern and central basins	yellow perch	1965-7	100	muscle & whole fish	0.06				
	sheepshead	1967	6	muscle	0.20				
		1967	4	gonad	0.37				
	white bass			muscle	0.29				

Present water use by communities in Norfolk County is shown below.

Smaller villages are dependent on private wells and septic tanks. Because of the prevalence of sand, soil pollution is not a problem at the present low population density. Several privately owned watersheds supply shoreline communities.

Although only very limited data on pesticide residues in fish is available at time of writing, there is no evidence of a general build-up of residues dangerous either to fish or humans in Inner Long Point Bay or the open lake (Table 10-9).

Municipality	Population	Water Source	Sewage Disposal
Delhi	3,700	springs and wells	sludge digestion, primary and secondary treatment, discharge to Big Creek
Port Dover	3,500	Lake Erie and Creek	primary treatment discharging into Lake Erie
Port Rowan	850	Long Point Bay	septic tanks and stormsewer to Inner Long Point Bay
Simcoe	10,500	wells and infiltration channels	complete treatment; discharge into Lynn River
Waterford	2,500	drilled wells	one large sewage lagoon; discharge into Nanticoke Creek

Summary and Recommendations

Table 10-10/Comparative Bi-monthly Physical and Chemical Data for Lower Big Creek and Inner Long Point Bay for the Period 30 May — 6 September, 1962.

		Total Solids	Turbidity	pH	Phosphate	Free Ammonia	Nitrate	Nitrite	Total Alk.	B.O.D.
May 30	creek	326	11.3	—	0.18	—	—	—	—	0.13
	bay	202	5.9	—	0.06	—	—	—	—	1.8
June 13	creek	293	26.0	—	0.19	0.06	0.40	0.01	—	3.2
	bay	180	5.2	—	0.06	0.12	0.00	0.00	—	2.4
June 27	creek	267	11.0	8.1	0.19	0.13	0.30	trace	180	1.4
	bay	145	3.0	8.1	0.08	0.15	0.00	0.00	86	1.0
July 11	creek	329	9.0	8.2	0.13	0.07	0.08	trace	165	2.0
	bay	166	3.7	8.3	0.05	0.03	0.00	0.00	59	1.0
July 26	creek	323	—	—	0.16	0.08	0.25	trace	170	0.8
	bay	157	—	—	0.06	0.07	0.00	0.00	61	0.9
Aug. 9	creek	306	10.8	—	0.13	0.06	0.20	0.00	175	1.1
	bay	150	4.0	—	0.09	0.10	0.00	0.00	66	0.9
Aug. 22	creek	353	10.0	8.3	0.16	0.16	0.25	0.01	182	1.4
	bay	185	3.9	9.0	0.07	0.08	0.00	trace	65	1.4
Sept. 6	creek	327	20.0	8.5	0.20	0.16	0.10	0.01	177	1.0
	bay	195	4.1	8.8	0.09	0.11	0.00	0.00	64	1.4
Seasonal average	creek	315.5	14.0	8.2	0.17	0.10	0.23	0.06	174.8	1.5
	bay	172.5	4.3	8.6	0.07	0.09	0.00	trace	66.8	1.4

Data from Berst, A. H. and H. R. McCrimmon, 1966. Comparative summer limnology of Inner Long Point Bay, Lake Erie, and its major tributary. J. Fish. Res. Bd. Canada 23 (2): 275-291.

The surface waters of Haldimand and Norfolk Counties all reflect poor land and water use practices (Map 10-1). Surface waters in Haldimand County and the western limits of Norfolk County (Woodhouse and Townsend Townships) are inadequate to meet present needs for potable water and for the discharge of municipal effluents. The Grand River, already highly eutrophic on entering Haldimand County from the north, remains impaired throughout the county by the addition of effluents from river-side communities and, in some locations, bacterial pollution approaches a dangerous level.

The smaller watersheds, including the tributaries of the Grand River, typically have greatly reduced summer flows of turbid water and are totally inadequate to handle effluents of agricultural, domestic, or industrial origin. Further, the clay soils of Haldimand County are generally unsuitable for subsurface sewage disposal systems and, consequently, soil pollution occurs even in small communities. The unique chemistry of local groundwater limits its use for domestic purposes in several parts of the county.

The present problem of water shortage can probably be overcome only by installing one or more water supply networks which would make Lake Erie water available to all communities and, preferably, to agricultural operations as well. The use of cooling water from the new Ontario Hydro steam generating plant at Nanticoke should be seriously considered for this purpose. This would also decrease the potential ecological dangers in returning heated water directly to Lake Erie.[5] The controlled discharge of this water into the Grand River, its tributaries, Nanticoke Creek, and perhaps the Lynn River could conceivably be used to stabilize and maintain adequate seasonal flows and thereby improve the capacity of these waters to handle totally treated domestic and industrial effluents and provide obvious esthetic and recreational benefits. A feasibility study should be undertaken immediately to determine the cost and practical benefits of the use and re-use of the cooling water discharge from the Nanticoke plant.

Problems in water and soil pollution existing generally throughout Haldimand County, and along the eastern limits of Norfolk County, require a network of sewers leading to one or more strategically located sewage treatment plants. Local sewage lagoon or treatment facilities could be incorporated into the total system.

Water quality on virtually all watersheds in Norfolk County on the sand plains is affected adversely by present agricultural practices, largely related to tobacco farming. The excessive withdrawal of water for irrigation, the mutilation of stream beds and banks, the drainage of wetlands, and the encroachment of cultivated land on water courses are totally detrimental to the aquatic environment. They cause low or intermittent summer flows and high summer water temperatures in smaller streams, and a general condition of turbidity and siltation in all watersheds.

Of Norfolk County watersheds, only the main water courses of the Lynn River and Big Creek have the flow capacity to receive treated sewage

Table 10-11/Coliform Counts per 100 ml, from Beach Areas in Norfolk County, 1969.

		2 May	16 May	29 May	26 June	2 July
Turkey Point Provincial Park 6 stations	T.C.	31	25	31	2694	
	F.C.	2	6	2	142	
Long Point Provincial Park 6 stations	T.C.					
	F.C.					
Waterford Lakes 2 stations	T.C.					38
	F.C.					6
Long Point Beach 3 stations	T.C.					143
	F.C.					23
Turkey Point Beach 9 stations	T.C.					6256
	F.C.					570
Port Dover Beach 3 stations	T.C.					134
	F.C.					35
Hay Creek Beach 2 stations	T.C.					105
	F.C.					4
Port Ryerse Beach 3 stations	T.C.					123
	F.C.					30

Data extracted from information provided by Norfolk-Haldimand Health Unit.

effluents and, at present, eutrophication exists within and below Delhi (on Big Creek) and Simcoe (on Lynn River). The capacity of these stream systems to handle increased municipal discharges without serious effects on water quality downriver will depend on the efficiency of the sewage plants.

Because of the low human population density and the general absence of industry on rural watersheds and the substantial supply of spring water, the smaller watersheds (including the tributaries of Big Creek and those of the Lynn River on the sand plain) in the Lake Erie drainage have remained more or less free of organic or chemical contamination, and enrichment is not generally pronounced. Siltation is general, however, on all watersheds and high seasonal turbidities occur, especially on waters passing through the clay plains.

The waters of Lake Erie fronting Haldimand and Norfolk Counties are moderately to highly eutrophic with the possibility of serious bacterial pollution a reality along public beaches and fronting cottage settlements. Untreated effluents entering the lower reaches of the three major watersheds (*i.e.,* the Grand River at Cayuga and Dunnville; the Lynn River at Port Dover; and the Otter Creek at Port Burwell in Elgin County) all contribute substantially to regional eutrophication of the lake. Also, present high water levels in Lake Erie increase the hazard of pollution from cottage and marina septic tank systems, particularly in Inner Long Point Bay. All major watersheds, including Big Creek, contribute a continuous load of dissolved and suspended solids to the lake while the smaller watersheds, particularly those on the clay plains, contribute continuous or seasonal silt loads to the lake.

The rapid eutrophication, siltation, and aquatic weed growths and threat of major bacterial pollution in Inner Long Point Bay (attributed to discharges from Big and Dedrick Creeks coupled with untreated effluent from Port Rowan, and likely some enrichment from local marinas, boats, and cottage settlements) is critical and immediate remedial action is essential if the present uses of the Inner Bay are to be preserved and the environment restored to a prior quality. In addition to initiating stringent pollution control measures, the benefits and ramifications of a re-diversion of Big Creek to its former lake entrance should be investigated and appropriate action taken to settle the present local controversy on the feasability of a re-diversion (Figure 10-2).

In view of the recent recognition of the seriousness of fish contamination by heavy metals in Lake St. Clair and possibly the western end of Lake Erie, a more detailed investigation of the situation relative to the sport and commercial fisheries in the Haldimand-Norfolk region is warranted, especially in the lower Grand River, Long Point Bay, along the lakeshore, and in the trout streams of Norfolk and east Elgin Counties. No evidence of serious contamination from mercury has been found in these local waters but continuing monitoring for heavy metals and other chemicals including arsenic, pesticides and herbicides is imperative.

Recommendations

1) It is imperative that sound soil and water conservation practices (*i.e.,* turfing, reforestation, bank stabilization, flood and flow control, etc.) be instituted immediately on all watersheds in Haldimand and Norfolk Counties, including tributaries in Oxford, Brant, and Wellington Counties, to reduce runoff, erosion, siltation, etc. and improve the availability and quality of surface waters.

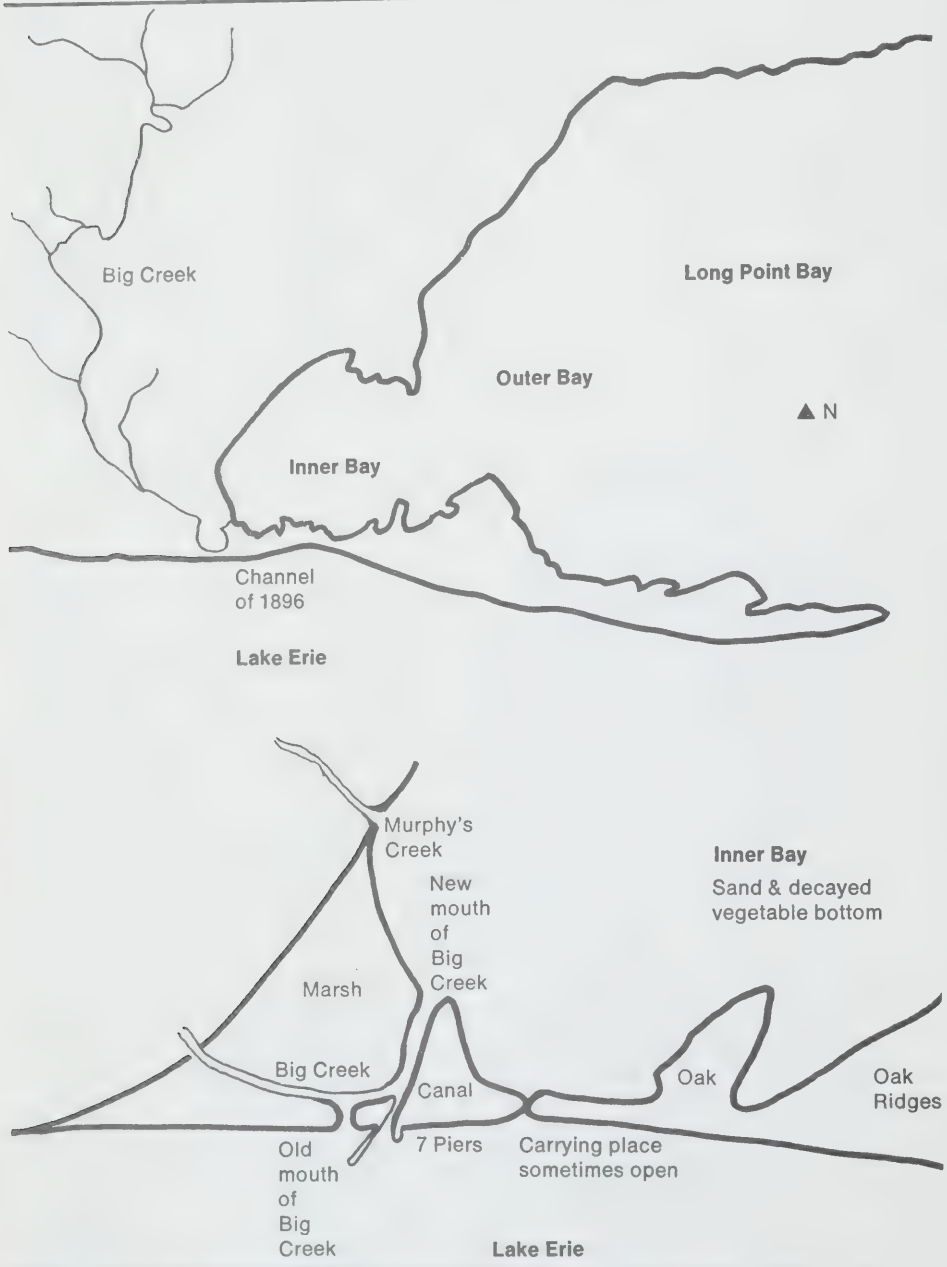
8 July	28 July	4 August	25 August	2 September	8 September
	4675	16808	10283		1850
	173	766	111		47
1600	740	44	79	57	850
38	155	4	2	8	7
	1510				
	53				
	49000				
	261				
	12250				
	255				

Table 10-12/Coliform Counts per 100 ml, from Beach Areas in Haldimand County, 1969.

		2 July	6 August	13 August	18 August
Lowbanks Marina, Moulton Twp.	T.L.	70	—	385	—
3 stations	F.L.	15	—	50	—
Pine Grove Park, Sherbrooke Twp.	T.L.	60	—	60	—
2 stations	F.L.	7	—	50	—
Rock Point Provincial Park	T.L.	72	—	1308	—
3 stations	F.L.	6	—	0	—
Port Maitland shore	T.L.	—	—	4240	—
2 stations	F.L.	—	—	7	—
Splatts Bay, Dunn Twp.	T.L.	193	—	—	—
3 stations	F.L.	2	—	—	—
Sandy Bay	T.L.	23	17	17	—
2 stations	F.L.	1	3	3	—
Hoffman, Knights, Lloyd, Nida,	T.L.	84	37	—	—
Selkirk, Smelsers, Wardells Beaches	F.L.	5	9	—	—
17 stations					
Selkirk Provincial Park	T.L.	55	1500	—	1200
3 stations	F.L.	7	69	—	440
Peacock Point	T.L.	145	—	—	2350
2 stations	F.L.	1	—	—	440
Haldimand County Park	T.L.	293	—	—	2500
3 stations	F.L.	1	—	—	49

Data extracted from information provided by Norfolk-Haldimand Public Health Unit.

Figure 10-2/Inner Long Point Bay Showing Original and Present Location of the Mouth of Big Creek. (Taken from Laidler, G., Long Point Bay, Lake Erie: Some Physical and Historical Aspects. Papers and Records of the Ontario Historical Society, 1944, 36:48-69.)



2) In view of the persisting use of Norfolk County streams by salmonid fishes, sound principles of soil and water management are mandatory and appropriate legislation must be rigidly enforced, particularly in areas under intensive cultivation for tobacco and other cash crops. Special features should include:
a) compulsory grassed and/or wooded corridors between cultivated land and streambanks in order to suppress runoff and erosion and thus protect stream banks, stabilize the flow, quality, and temperature of the water, and reduce stream turbidity and siltation.
b) protection of water courses and river beds by permitting physical alteration only under permit granted by a competent authority acting in the interest of the public at large.
c) re-evaluation of allowable limits on water withdrawal for irrigation from watercourses which, in many cases, is now grossly excessive. A more rigid enforcement of present and new regulations is imperative.

3) New refuse dumps must be established within both counties which meet rigid health and pollution standards. Such dumps must be located where there is no possibility of the leaching of organics, chemicals, or toxic wastes into natural watercourses or groundwater. This will require the closing of most, if not all, of the existing dumps.

4) More rigid controls must be established and enforced on agricultural water use and on the quality requirements for wastewater, sewage, and stormsewer effluents discharged directly into Lake Erie or into watersheds within the Haldimand-Norfolk region.

5) All presently undeveloped or misused river valleys within the region should be set aside as no-development areas and appropriately managed. They should be incorporated within an integrated land use plan for all rural areas in order to preserve and restore aquatic environmental quality.

6) Any urban or industrial development in Norfolk County should be limited to existing communities, and must be conditional on the pre-existence of adequate (non-river) water supplies and facilities for the total treatment of sewage and waste water.

7) Because of an inadequate water supply and the present low level of human occupancy, that part of Haldimand County to the east of the Grand River, excluding settlements along the river, must be left as a no-development zone pending a demonstrated need for development and the solving of water

supply and allied pollution problems.

3) It is imperative that a planned integrated water supply and sewage network serving the lower Lynn watershed of Norfolk County and all of Haldimand County west of the Grand River precede any further urban or industrial development in order to overcome existing sources of pollution and prevent a further defilement of the aquatic environment. A regional water supply using Lake Erie water (drawn from the offshore hypolimnion) should serve agricultural as well as urban and industrial needs.

) Serious consideration must be given o the potential uses for the discharged cooling water from the new Ontario Hydro steam generating plant at Lanticoke. It may possibly be used to meet the domestic, agricultural, and ndustrial requirements of Haldimand County and the eastern limits of Norfolk County on the Nanticoke and Lynn Watersheds. Consideration should be iven as well to the esthetic and ecreational potential of this water if umped inland to create reservoirs and onnecting waters. A vital aspect of e-use is that the heated water would ot be discharged directly into Lake rie but rather that the heat would be issipated through a circuitous route the lake, conceivably via the rand River.

)) It is imperative that no effluent be scharged into the littoral (onshore) aters of Lake Erie which differs ermally from the lake water, or is emically or physically of inferior ality. To do otherwise not only opardizes the future of the Lake Erie hery and the esthetic values which e lake provides for fishing, hunting, itdoor and aquatic recreation; but the mbined effects of increased water mperature, organic overload, toxic emicals, and natural limnological ctors may impair its suitability for mestic supply and present serious cial and public health problems.

) Immediate steps must be taken to prove water quality in the Grand River within the Counties of Wellington, Brant, Oxford, and Haldimand, particularly with respect to suspended solids, nutrient levels, and heavy metals.

12) Steps must be taken immediately to eliminate the continuing eutrophication and siltation of Inner Long Point Bay if its present uses are to be maintained indefinitely. It is imperative to formulate a concrete plan of action at the earliest moment if the future of this multi-recreational resource is to be preserved for social and economic benefit. The potential benefits and dangers which would result from the re-diversion of the Big Creek outlet to its original location must be considered.

13) More frequent and, at critical locations, continuous monitoring of water quality is imperative if existing or new sources and levels of pollution are to be identified. The analysis of chemical residues in sediments and in the tissues of commercial and sport fish and other animals must form a vital aspect of the monitoring procedure if threats to wildlife and human health are to be identified and corrected.

14) Although the extensive use of pesticides and other agricultural chemicals, especially in Norfolk County, does not seem to have had the adverse effects on stream and lake fish or associated invertebrate fauna which might have been anticipated, the potential hazards of chemical pollution to fish, wildlife, and public health must be recognized and appropriate controls implemented.

Footnotes

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Properties and Characteristics of Soils

The properties and characteristics of natural soils depend upon local conditions, environment and geological history. The physical properties of soil by which an engineering classification might be made here have not yet been measured in this region. A judgment approach must therefore be a general one, based on experience with similar soils in other locations but modified by scattered investigations made in the region. When more detailed physical properties have been determined in a re-survey of the area, an engineering classification and interpretation might be made.

Urban Soil Requirements

Generally, urban land need not be fertile, or flat or even dry. Physical properties of soil which influence urban development or urban amenity are soil permeability and percolation, bearing strength (the ability to support a load), shrinkage and swelling characteristics, corrosion potential and so on. These properties will be reviewed by general soil textural classes.

Suitability by General Type

Coarse-textured sand soils, similar to those found in large portions of Norfolk and Brant, are well suited to most urban development. The soils transmit water rapidly to lower levels, are readily compacted and have low shrinkage characteristics. They are easily excavated and less sub-base course is required for roads and parking lots. Drainage is good for basements and septic tanks work where the water table is not near the surface. Settlement of structures is not a problem.

Silts and loams with sand or gravel substratum are well suited to urban development and their characteristics are similar but somewhat inferior to the coarser soils. Steep slopes associated with such soils present problems that preclude certain developments since grading costs are higher and sewer costs increase. A few frost boils occur in these soils on roads in Oneida and Oakland townships. Preventative drainage facilities are required to improve their performance.

Fine-textured soils such as those comprising the greater portion of Haldimand, Brant and the eastern portion of Norfolk may have a higher bearing strength when dry than the coarse-textured soils; the opposite is true under wet conditions. Water movement is slow through the soil and construction time is wasted waiting for the soil to drain. In road construction French drains are used extensively in the region to dry the sub-base of the road. These soils have a high water content and may shrink and swell, presenting waterproofing problems with basements. The soil also is a poor medium for septic tank effluent disposal.

Summary and Recommendations

Artificial fills require a longer time to settle in fine textured soils and with road construction current practice is to use 18 inches of Granular B base course and 6 inches of Class A Select Granular material as cover. This additional material increases the cost of initial construction. Slippage planes develop on steep side banks in Onondaga and Seneca, particularly along the Grand River. Slopes constructed less than 3:1 appear to assist in reducing this problem. Ditches are constructed about 4 feet below the crown of the road to ensure adequate drainage. Settlement of structures has not been a problem in the region. However, the imposed loads have been rather light to date.

Rock is found at varying depths in the eastern portion of the region. Where it occurs at appropriate depths, it would no doubt serve as a very satisfactory foundation. The cost of underground services would be very high in areas where rock is within 4 feet of the surface.

In conclusion, it is the author's opinion that the soils of the region are generally well adapted to large-scale urban development and living. No serious problems, other than the wetness of the clay soils, have appeared and from the engineering point of view no area may be eliminated from a development program due to soil conditions generally. It should be pointed out, however, that since soil conditions vary locally, no major building or structure should be constructed without an adequate foundation investigation by experienced soils engineers.

Footnotes/References

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Rationale

Man has two requirements which are basic to his existence. One is the fulfillment of his physical needs, and the other is his need to satisfy his emotional sensibilities.

Most of the foregoing chapters have dealt largely with the former; this chapter attempts to deal more with that part of environmental resources and processes which give spiritual sustenance. However, as this spiritual dimension is part physical and part meta-physical this chapter on landscape quality must deal with both natural and cultural aspects of environment — pure at either end of the scale, and highly integrated (or desirably so) in the middle ground.

In this context, then, it is recognized that for man and other living organisms of a region to remain physiologically healthy, a certain perpetuating balance must be maintained within all the parts of the region. This balance includes not only living entities but the physical base of soil, water, and air as well. It is a problem of maintaining habitability which undeniably involves the preservation and conservation of natural resources allowing survival of all of those forms of life peculiar to the region. This obviously demands observation and analysis of use and abuse of land involving practices which affect the physical and biological base, for example, erosion of soil, disturbance of the water regimen and pollution of air.

But emotional well-being is also expressed physiologically and, in man, can be achieved only through satisfaction of his perceptual sensibilities. For this he relies upon a large pool of sensory stimuli, esthetic in character and involving emotion, feelings, color, passion and so on. Many of these stimuli are derived from nature, ranging through a broad spectrum of natural and cultural features and relationships terminating at that state which is considered purely social in character.

This study of landscape quality would therefore not restrict itself to a traditional definition of landscape. Rather, landscape is considered here as the regional environment in which the people of the Study Area live and this includes, as has been stated above, considerations ranging from natural landscapes to certain human activities.

It was the objective of this study to conduct an inventory of the landscape, to analyze it from a qualitative point of view and, as a result of this analysis, to identify its positive and negative values and to recommend action for its preservation, development and redevelopment. The study was conducted recognizing that large-scale urbanization can bring about economic development which can yield an improved standard of living. However, it was also recognized that a precious and vulnerable landscape, central to the achievement of a high quality of life, will be effectively eliminated in the absence of planned and integrated development. Thus the contradiction of economic development must be avoided through a rational approach to land planning and resource use to achieve a rich existence without destruction of critical resources.

The following is a partial list of landscape considerations and characteristics studied:

Landscape acquisition and protection
Parks and recreation areas
Unique natural habitats
Wildlife preserves
Scenic areas
Historic sites
Countryside quality

Facilities for:
Swimming
Fishing
Boating
Water-skiing
Picnicking
Hiking
Cycling
Camping
Horseback riding
Outdoor education

Roads
Transportation needs
Scenic vistas
Turnouts and rest areas
Scenic highways and parkways
Picnic sites
Bridges
Billboards, junkyards and other blight
City approaches
Landscape treatment

Miscellaneous resources, opportunities and problems:
Utility rights of way
Unused railways, canals, roads
Access to water bodies and other recreation sites
Waterfront and landscape enhancement
New techniques for reserving open space: conservation easements, etc.
Urban quality
Architecture (industrial, urban, rural)
Surface mining
Scattered residential development
Recreation subdivisions
Indiscriminate cutting of vegetation

Techniques

The field work for the study of landscape quality was accomplished essentially by the "windshield survey" technique; almost all the roads in the Study Area were driven and the natural and manmade features of the landscape recorded. These features were recorded simultaneously on file cards and topographic series maps by both written and graphic notation. Photographs were made of specific items of contrast and significance as well as those characterizing the several landscape personalities. The photographs, file card and graphic notations were each keyed to military grid cells superimposed on the topographic series maps. A concise written and graphic summary was made for each topographic series sheet as it was completed.

While the field observations resulted in emphasis on a comprehensive record of the visual inventory of the varied landscape characteristics, land use was frequently recorded as well because of its obvious influence on visual quality. A conscious bias was exercised toward the natural resource base and its recreational potential.

The major natural and manmade elements of the landscape were recorded and analyzed graphically according to the method devised by Philip Lewis, Jr.[2] These were recorded on a map of the Study Area by symbol and number coding; they were supported by complete chart reference, description and brief discussion of potential, which appear in App D.

After analysis of all this information, landscape personalities were outlined and patterns and corridors of natural and manmade features were delineated. The quality, character and locational significance of the individual landscape features and their patterns, along with consideration of potentials and trends in recreational and general development, comprise the basis of graphic and written recommendations.

Landscape Inventory (Natural and Manmade)

Water

The Study Area is generally bounded with significant water features — on the south by Lake Erie, on the east and northeast by the Grand River and on the west by the Big Otter Creek. The presence of water is accentuated in varying degrees by landform. The high cliffs of the Lake Erie shoreline, the broad valley of the Grand River and the deep, wooded valleys of the Big Otter and Big Creeks illustrate this variable aspect. Excellent views and the drama of overlooking water is largely minimal, however, mainly because of the road locations and limited accessibility. Visual contrast varies from the broad expanse of lake water to small trickling or placid streams and clear sparkling water in quarries. This variety of water experience can be articulated with sensitive planning and development approaches and techniques.

Lake Erie

In certain places the Lake Erie shore offers excellent views, especially from Long Point through Turkey Point to Port Dover. Here the lakeshore road offers access to views of marshlands, beaches, recreational facilities and woodlands. However, in other sections many potential views are limited or non-existent. West of Port Burwell, as in many other areas, the road is separated from the shore by a broad strip of farm lands. In some cases, such as at Mohawk Point, views are restricted from high bluffs by heavy vegetation along the shoreline and on the bluffs. Near Willow Bay and Lowbanks views are restricted by cottage development along the lakeshore. The visual experience of the lake water is severely impaired by the sight and smell of rotting algae, domestic waste and dead fish — the results of pollution. The smell of domestic wastes is particularly noticeable in the cottage areas west of Selkirk. Onshore winds in some areas, such as Mohawk Point, cause considerable wave action resulting in onshore piling of algae, floating debris and turbidity. In these areas water quality is very low and rigidly enforced anti-pollution laws are necessary. Accessibility for viewing is unavailable here as in many other areas. Accessibility for use of beaches and related activities is a serious problem. The existing road system provides few links to the beaches, and high cliffs and cottage developments tend to isolate the beaches from the public. These problems of accessibility must be overcome so that the potential of the lakeshore for recreational use can be realized.

Many small, sheltered *harbors* for fishing and pleasure craft exist along most of the Lake Erie shoreline. The picturesque harbor at Port Burwell can be viewed from the bridge across the Big Otter Creek. Fishing activity can be viewed at Port Burwell, Port Dover and Port Maitland, as well as at a number of smaller fishing ports. The fishing harbor at Port Dover is also developed as a marina and "honky-tonk", youth-oriented resort. Booth's Harbour seems to indicate the great demand for boating facilities; it is overcrowded and development is very active.

The *beaches* illustrate the varied nature of the Lake Erie shoreline. Swimming beaches of fine sand are found at Port Burwell, Port Ryerse, Lon Point, Rock Point, Fisher's Glen, the Sand Hills, Turkey Point, Port Dover, Port Maitland and Evans Point. The bes of these, and perhaps the best beach on the north shore of Lake Erie, is at Long Point. Gravel and pebble beaches are common. Some of these have potential as bathing beaches, such as the development at Lowbanks. Minor variations in beach type include dolomite bedrock exposures in the vicinity of Mohawk Point, and limeston blocks which have been dumped in places along shore to reduce erosion. Features of the beach in the Lowbanks area include offshore boat hangars and piers at cottage developments along the shoreline. Other features occurring at the various ports are lighthouses, breakwaters and harbor markers. The most significant of these the lighthouse at Long Point.

Shoreline erosion is currently one of the greatest problems and constitut a significant deterrent to recreational development. High clay cliffs in certai areas are subject to water erosion fro runoff and wave action, and sand cliffs

are exposed to the added problem of wind erosion. Methods used in other shoreline areas could be implemented here to reduce the problem and the inherent dangers, although the legal implications referred to below must be recognized.

Inland Lakes
Inland lakes within the Study Area are few in number and very small in scale. They are virtually undeveloped, but some appear to have potential for recreational use. None of these lakes exceeds 70 acres in size and are therefore best considered as an element of interest within the larger context of a recreation or open space corridor. Four urban lakes are of the greatest significance primarily because of their location; these are Mohawk Lake in Brantford, part of the Lynn River in Simcoe, Waterford Pond and water filled quarries in Waterford, and Silver Lake in Port Dover.

Urban parks using these small lakes should be integrated into regional open space systems which would include the streams that feed these water bodies. Water quality varies from the extensively polluted Mohawk Lake to Colles Lake which is usually good. Many of these small lakes are spring fed and have marshy shorelines. Some, such as Colles Lake, are ideal for swimming and fishing.

The area northeast of Woodstock contains seven bodies of water out of which several streams flow. These small lakes together with poorly drained land act as natural reservoirs to maintain water tables and control flooding. There is no recreational development and only one lake has access, but potential exists for water-oriented recreation as long as the water table is not altered further. The Blue Lakes northeast of Paris are examples of attractive, privately owned small lakes with public recreational potential.

Rivers
The only major river in the Study Area is the Grand. Its importance is considerable in relation to source of water drainage, effluent disposal, landscape amenity and vast recreational potential. Visually, the river and the valley provide a type of water-based interest in the landscape that is lacking elsewhere in much of Haldimand County. Views across the Grand range from the picturesque at Paris to the pastoral landscape of the Tuscarora Indian Reserve. It is a dominant feature of the landscape, having determined the pattern of development for Paris and Brantford by acting as a natural barrier to the southward growth of these towns. Attractive river bank settlements such as Onondaga and Middleport add to the interest quality of the Grand. It has particularly significant potential as a major recreation corridor, tying together the many fragmented natural and man-made features of the area and providing a strong recreational, visual and functional link with Lake Erie.

Streams
Several streams in the Study Area are of appreciable size, the Big Otter and Big Creeks being the largest and the most scenic. They are typical of the creeks and tributaries in the sand plain, with deeply incised valleys and steep, wooded banks which are a strong contrast to the flat sand plain. The tributaries of the Big Otter and Big Creeks are also well defined. They have major recreational potential. However, they are largely inaccessible to the public because of private ownership.

The Boston, McKenzie and Oswego Creeks, all tributaries of the Grand River, are of appreciable size but of limited visual impact because of the shallow profiles of their stream channels.

There are numerous small streams. Some of these are intermittent in nature, some of very little significance, while others are particularly interesting and hold potential as strong visual and functional qualities. Small streams such as the Lynn River, Fairchild Creek, Spittler Creek, Branch Creek, Sandusk Creek and Black Creek could be integrated into the regional matrix of the open space system to provide sequences of intimate landscape experience.

Mill Ponds and Dams
Other significant water features in the Study Area are the numerous mill ponds and dams, such as the Vivian Pond, Quance Mill Pond and Smith Mill Pond. These ponds are frequently found in villages and should be developed to meet local recreation demands emphasizing their historical background. There are numerous dams on the Grand River but they are in poor condition and therefore seriously hamper boating on the river.

Canals
A very important water feature from a historical aspect is the abandoned Welland Feeder Canal. It actually consists of two feeder canals — one from Dunnville to the mouth of the Grand River, and the other from the mouth of the Grand to Welland. These disused canals act as drainage outlets and are water-filled in places or choked with cattails and water lilies. They have been filled in many places but still dictate much of the development pattern of the area. They are very straight, about 50 to 60 feet wide and 10 to 15 feet deep. Action should be taken to realize the potential of these feeder canals for recreational and historical reasons. These could be related to the historic artifacts of the pioneer era identified in following discussion.

Wetland
Wetlands are a significant feature of the Study Area. Marshes, swamps and poorly drained areas constitute some of the major natural resources. Major marshes such as those at Turkey Point and Long Point are significant not only as isolated entities but because sand beaches, river mouths, woodlands and land features are all in close proximity.

Marshes
In general the major marshes are accessible visually if not physically. Views of some of these marshes are dramatic and, including Point Pelee farther west, almost unique to southwestern Ontario. The Turkey Point and Long Point Marshes are of exceptional quality, important from an ecological standpoint as well as from the visual.

Turkey Point Marsh. The Turkey Point Marsh is bordered mainly by forest lands and on the north by a high cliff, while the west is open to the lake. The marsh area of about 5000 acres is very flat and open in character, being covered with high marshland vegetation. As with Long Point Marsh it is important for local and migrating waterfowl.

Long Point Marsh. Long Point Marsh extends from the South Walsingham-Houghton township line along the lakeshore to the tip of Long Point. A dramatic view of the marsh contiguous to South Walsingham may be had at ground level from the causeway of Highway 59, in contrast to the vantage point afforded by the northern cliff over the Turkey Point Marsh. Long Point Marsh consists of approximately 5000 acres. The presence of several small treed islands and the tree-lined causeway detract from the visual impact of its expansiveness. Consideration should be given to the removal of the latter trees.

Grand River Marshes. A fairly large area of marshland occurs along the Grand River from Cayuga to Dunnville. The river widens and slows in this area and the valley effect is less pronounced, giving rise to shorelines composed mainly of marsh, varying in width from a few feet to one-half mile. Evidence of waterfowl and other wildlife is seen in these marshes, especially in the Byng Conservation Area near Dunnville. These marshes have been considered for wild rice production which conflicts with their natural character and their long-range recreational potential.

Future consideration of these marshes should recognize their ecological vulnerability. Physical development practices, if necessary, should be designed to perpetuate their present state.

With the exception of a few small marshy lakes near Scotland, Burford and Waterford, the Turkey Point, Long Point and Grand River Marshes constitute the major marshlands in the Study Area.

Swamps

Major swamps, such as the Canborough, Oakland and Burford Swamps, serve as natural catchment and water holding areas, are sources for numerous streams and contain some of the largest forest areas in the Study Area. They are much less accessible than the marshes because construction problems have limited the number of roads built through them. No high landforms surround them to serve as vantage points. In general, therefore, their visual impact is not high.

In some, such as the Oakland Swamp, encroachments are destroying their ecological value. Here a major highway bisects the swamp and numerous irrigation ponds have been constructed at its periphery.

The major swamps within the Study Area are sources for various streams which are important to the visual quality of the landscape, as well as for purposes normally associated with a regional water regimen. The Oakland and Burford (Horner) Swamps are bordered by a 50-foot ridge on the west. Both of these swamps are approximately 4 miles long and one and one-half to 2 miles wide and are about 4 miles apart. Their visual quality is not high, but they are the sources for the Big, Horner and McKenzie Creeks serving as catchment areas for the runoff from many thousands of acres of agricultural land. They constitute the only major forested land in this particular area.

A major swamp area of many acres in Blandford and Blenheim townships influences the water table and water source for a large portion of Norfolk County. This swamp is not in the Study Area, but its influence is significant.

The Canborough Swamp is a vast acreage of heavily forested swampland which acts as a water storage area and source for the Welland River and Oswego Creek. It is important to regional and local water levels and as yet has seen very little development.

Many smaller but nonetheless important swamps are found within the Study Area. Most of these are sources for the numerous small streams, constitute much of the natural forest areas, and are wildlife habitats. The Tuscarora Indian Reserve has much swampy land where the McKenzie and Boston Creeks are located. The swamp area north of Courtland is the source of the Little Otter Creek. The sources of Spitler and Branch Creeks are small swampy areas, as are the sources of the Venison, Big, Young, Nanticoke and Patterson Creeks and many others. The Taquanyah Wildlife Preserve and Dry Lake are feeding grounds for ducks and a source for a tributary of the Grand River. The Moulton Swamp is fairly extensive in size and contains associated vegetation. This area is projected for forestry use by the Ontario Department of Lands and Forests.

Bogs

Peat bogs and areas of organic soil are rare in the Study Area. One example of a fairly substantial area of organic soil is found near Hatchley. This is a flat low area of sand and organic soil which is now being cleared, drained and stripped, to the detriment of natural drainage processes and water catchment.

Topography and Geology

The Study Area is not well endowed with unique or dramatic topographical and geological features. This is unfortunate as the major features of landform contribute to a large extent to the constituent and regional personalities of any area. Also, topography and water features are very closely related in most cases to accentuate items of landscape interest. The Grand River valley, the Lake Erie bluffs, and the deeply cut wooded stream valleys o Norfolk County are the major topographical features related to major water features. The clay plain, sand plain and hilly topography of the Brantford-Norwich-Burgessville area are the other major topographical features. There are a few small-scale landforms which are also important to the landscape of the Study Area. These do not necessarily contribute to the regional character, but are of local significance and either possess potential for accommodating various activiti or serving as deterrents to them. The

numerous creek and stream valleys fall into this category, as do certain sand ridges and isolated lowlands. Only one unique landform is found in the Study Area, that of the Sand Hills near Port Burwell on the Lake Erie shoreline.

The visual quality of landform in the Study Area is limited resulting in restricted views or in low scenic quality in many areas; access to water bodies and potential recreation sites is restricted in many situations and topography provides little opportunity for absorption of development while maintaining the natural character of the landscape. These limitations can be overcome through examination of the deterrents to access as outlined in the sections on "Water" and "Wetland". The flat plains are examples of the low development absorption capacity of much of the Study Area. Therefore, careful consideration of these landscape elements must be made preceding development.

Clay and Sand Plains

The flat clay plain of Haldimand having almost no topographic relief is monotonous. Manmade elements provide the only interest in the landscape; these elements, such as railway tracks, farm buildings, fences, etc., would be absorbed in any other landscape. Elements contrasting this clay plain are the broad Grand River valley and the high lakeshore bluffs. By comparison, the similarly flat sand plain of Norfolk County is endowed with deeply cut stream valleys and is enriched with forested areas, apparently rich croplands and well maintained, orderly farm buildings. The high cliffs of the lakeshore in this area also provide most dramatic contrast.

Grand River Valley

The Grand River valley is a topographic feature of major proportions. It presents a barrier to travel, more or less defines the eastern extremity of the Study Area and provides a wealth of potential for development, especially of a recreational nature. This river corridor begins near Paris as a deep, broad valley, providing a picturesque setting for Paris and unequalled views of the town and surrounding countryside. Progressing southward, views become shorter and more defined and, as the topographic relief flattens, the valley widens. Near the mouth of the river the valley is very broad and of such low profile as to be indiscernible, restricting views and lessening the visual impact of the water.

Shoreline Bluffs

The Lake Erie shoreline bluffs vary considerably from east to west. Near Mohawk Point they are distinct features due to erosion of the clay and sand material; exposed bedrock beaches are found here as well. The upland shore bluffs restrict views of the beaches, but provide an overview of the lowland to the north. They are from 25 to 100 feet high along much of the lakeshore. Beaches in these areas vary from a few feet to a several hundred feet in width and are almost always backed by a bluff line.

Similar bluff conditions are found in the western part of the Study Area. An exception, however, is Turkey Point where the forelands of the high cliffs of clay and sand consist of marshlands but give way to gentle forested slopes along the beach line.

These distinct bluffs along much of the lakeshore are a deterrent to access in many cases and present problems of erosion as far as shoreland use is concerned.

Stream Valleys

The deeply cut V-shaped stream valleys of the sand plain are features of major topographical interest. These valleys relieve the monotony of the plain, providing areas of forest and wildlife and amenities not found elsewhere in the Study Area. Views across and into these valleys are dramatic, although filtered and sometimes diminished by heavy vegetation. The flat to gently rolling sand plain becomes quite hilly near the stream valleys. These small stream valleys become virtual gorges, especially on the small tributaries in the sand plain. The ultimate effect of course is that of visual relief. This landform, combined with the water and vegetation features, make this an outstandingly beautiful area unsurpassed in landscape quality probably anywhere in southern Ontario.

Hills

The hilly topography of the Brantford-Norwich-Burgessville landscape is different from any of the major landforms of the Study Area. Panoramic and defined views, a high development absorption capacity and pastoral scenes are all qualities of this topographical feature. Although the change of elevation in this landscape is relatively little — usually 75 feet — the interplay of hills, knolls and gullies results in a landscape quality not found in the plains to the south.

Small-scale Features

A number of small-scale topographical features are found in the Study Area. These minor features allow a higher development potential than the major landforms discussed above, at the same time providing interesting sites and views. The till moraine of Mohawk Point rises 50 to 75 feet above the clay plain, providing panoramic views and a welcome contrast in the flat landscape. The low profile stream valleys of the clay plain, including the Tuscarora Indian Reserve and associated areas, provide some relief and recreational potential, but of a smaller scale and of less significance than that of the Grand River valley, the Lake Erie shoreline and the Big Otter and Big Creeks.

The numerous gravel pits and quarries near Brantford and Paris afford potential for residential and recreational development. The rolling landscape north from Caledonia provides a fairly high development absorption capacity. The gently rolling topography consisting of moraines and spillways near Woodstock affords panoramic views of the rolling landscape and relief from the flat plains. The 50-foot high sand ridge northeast of Eden and fragments of other ridges in surrounding areas provide topographical contrast and spectacular long views. These ridges afford a definition for views for they are easily seen and provide perspective across the flat plains. The long low slopes of the

spillways in this area rise to an elevation of 1000 feet, but are of very low absorption capacity. The spillways of flat poorly drained lowlands contrast with the rolling hills of the moraine.

There are few manmade land-oriented developments of a recreational nature in the Study Area, probably due to the lack of interesting landform. Golf courses at Brantford, Paris, Tillsonburg, Simcoe, Delhi and Turkey Point are generally lacking in natural topographic interest unless situated in river or stream valleys of high visual quality. Picnic areas and campgrounds are scarce, except those associated with the provincial parks and conservation areas along the lakeshore or with municipal developments along the streams. Trailer camps are situated near or adjacent to water, rather than landform.

Unique Landforms

Apart from the more or less major natural topographical and geological features outlined above, there are several small, isolated features which are rare or unique in the Study Area. A fossiliferous rock deposit near Windham Centre affords interest to souvenir seekers only, as the fossils are not of a rare variety. Bedrock exposures of 10 and 40 feet at Stoney Creek and Dry Creek, respectively, are dramatic isolated features. The bedrock beach west of Port Maitland is another interesting local feature.

The only truly unique landform in the Study Area is the Sand Hills, 150 feet above the lake near Port Burwell. At present the area is developed as a private park with picnicking and camping. It is becoming overused and erosion may well destroy this natural phenomenon of regional interest.

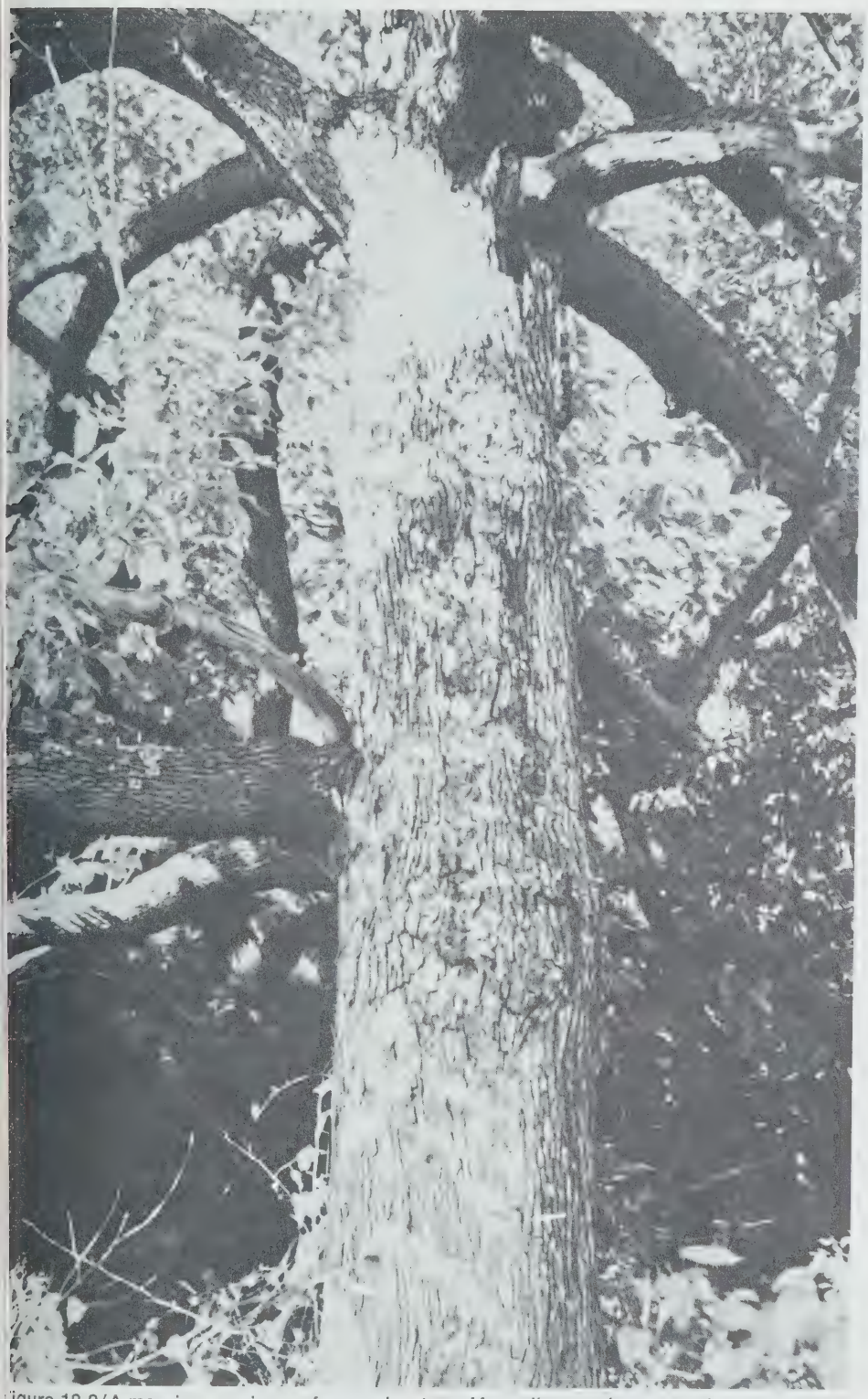
Long Point with its numerous sand ridges and beaches resulting from wind and water action is one of the most exciting landscape features in the Study Area. The complex interrelationship of landform, water, vegetation, wildlife and soil make for a very delicate ecological situation.

Potential in the form of topographical and geographical features is limited because of the scarcity of natural amenity. Therefore, it must be realized that the existing features of interest require careful consideration for development or preservation, and that development of the uninteresting plains and low relief areas must not occur without careful planning, for the lack of amenities related to landform make quality development more difficult.

Figure 12-1/A large specimen of the tulip tree, *Liriodendron tulipifera,* growing near the side of the road at the top of the Normandale Hill. This is one of the largest specimens of tulip tree in Ontario, a southern species known in only a few locations in the province.

Flora

Those portions of southern Ontario along the north shore of Lake Erie have long been of interest to botanists and phytogeographers because of their distinctive flora and because of the unusual distributional patterns shown b many of the plants native to this most southerly part of Canada. In 1898 Merriam divided the United States and the southern portions of Canada into seven "Life Zones and Crop Zones". H divided the southern peninsula of Ontario by a line drawn from the easter end of Lake Ontario to Windsor and designated the area to the south as the *Carolinian Area of the Upper Austral*



igure 12-2/A massive specimen of cucumber tree, *Magnolia acuminata,* growing on the utskirts of the hamlet of Walsh in Charlotteville Township. This specimen is one of the argest in Ontario of this rare Carolinian Zone species.

Zone. The area was subsequently re-defined to include that part of Ontario south of a line drawn from the north shore of Lake Ontario to Sarnia[3] and extended northwest to the shore of Lake Huron in the vicinity of Grand Bend.[4] Thus we see that the Haldimand-Norfolk Study Area lies wholly within the Carolinian zone.

As is implied by its name, the Carolinian zone supports native plants and animals which have affinities with more southerly areas. Thus, in this relatively small portion of Canada, consisting of a few thousand square miles, we find a large number of plant and animal species reaching the extreme northern limit of a range which may extend to Georgia, the Carolinas, Alabama and Mississippi, or at least to Virginia, Tennessee, or Missouri in the south. *An impressive number of these Carolinian species of the Haldimand-Norfolk area are to be found nowhere else in all of Canada.*

John Adams has written about the Carolinian element in the flora of Canada and has listed a number of families, genera, and species which he considered to be restricted in Canada to a southern region of Ontario.[5] The distribution of a number of trees and shrubs of the Carolinian Zone within Southern Ontario was carefully documented in the 1950's.[6] Additional publications by James Soper have resulted in a more precise understanding of the distribution of additional families and genera of our Carolinian flora.[7] Two other researchers have published annotated lists of the vascular plants of Norfolk County, the latter work based on more than 10,000 personal collections of herbarium specimens.[8]

In the views of these and other authors, the plants of the list given below, native in the Haldimand-Norfolk Study Area, are to be regarded as representative of a more southern flora:

Cyperus erythrohizos	Red-root cyperus
Scleria verticillata	Whorled nut-rush
Lilium philadelphicum	Wood lily
Erythronium albidum	White trout lily
Smilax hispida	Hispid greenbrier
Dioscorea villosa	Wild yam
Juglans nigra	Black walnut
Carya ovata	Shagbark hickory
Carya glabra	Pignut
Castanea dentata	Sweet chestnut
Quercus muhlenbergii	Yellow oak
Quercus prinoides	Dwarf chestnut oak
Quercus velutina	Black oak
Celtis occidentalis	Hackberry
Morus rubra	Red mulberry
Morus alba	White mulberry
Phytolacca americana	Pokeweed
Anemonella thalictroides	Rue anemone
Cimicifuga racemosa	Black snakeroot
Podophyllum peltatum	May-apple
Magnolia acuminata	Cucumber tree
Liriodendron tulipifera	Tulip tree
Asimina triloba	Pawpaw
Sassafras albidum	Sassafras
Lindera benzoin	Spicebush
Plantanus occidentalis	Sycamore
Pyrus coronaria	Wild crabapple
Agrimonia pubescens	Soft agrimony
Gymnocladus dioica	Kentucky coffee-tree
Lupinus perennis	Lupine
Vicia carliniana (caroliniana)	Wood vetch
Euphorbia corollata	Flowering spurge
Rhus vernix	Poison sumac
Ceanothus americanus	New Jersey tea
Vitis aestivalis	Silverleaf grape
Sanicula marilandica	Black snakeroot
Asclepias tuberosa	Butterfly weed
Asclepias exaltata	Poke milkweed
Hydrophyllum virginianum	Virginia waterleaf
Monarda fistulosa	Wild bergamot
Physalis subglabrata	Ground cherry
Aureolaria flava	Yellow gerardia
Conopholis americana	Squawroot
Iriosteum perfoliatum	Horse-gentian
Lobelia siphilitica	Great blue lobelia
Erigeron pulchellus	Robin's plantain
Helianthus decapetalus	Wild sunflower

The Study Area includes strikingly different habitats, in some instances separated from one another by distances of just a few miles. Some of the rarest of these *ecological associations* are located along the Lake Erie shoreline, and three are described in some detail below.

1) The Deciduous Forests of Charlotteville and South Walsingham Townships of Norfolk County

The famous Backus (Backhouse) Woods of the Port Rowan-Turkey Point area is one of the best extant examples of this majestic forest type. On the deep, rich, well drained yet moist soils of the Norfolk sand plains, and in a climate-modified band within 10 miles of the water of Lake Erie, there have developed remarkable deciduous forests with a decidedly Carolinian flavor. Immense trees of red and white oak, sugar maple, tulip tree, shagbark hickory and white ash form an impressive canopy. The understory shrubs of flowering dogwood, spicebush, and maple-leaf viburnum are botanically no less interesting than the canopy species. And on the forest floor is a rich mosaic of distinctive herbaceous species having their floristic affinities in some cases to the south, in others to the north or the far west. North of the Backus Woods the soils support a less magnificent forest, but here is found the rare southern dwarf chestnut oak, a species known from only one or two other stations in Canada.

2) Sand Hills and Sand Dunes

The sand hills, to the west of Clear Creek in Houghton Township of Norfolk County, are composed of wind-driven sand which forms hills and cliffs along the lakeshore to a height of from 140 to 160 feet above the level of the water. These impressive dunes are gradually encroaching upon landward forests, and the dead treetops project for a few years until completely buried in the sand or broken off and blown down. There is no protecting sandspit in the lake to influence the shoreline at this point, and the prevailing southwesterly winds have raised this tremendous volume of the lake sand.

Sand dunes are remarkably unstable ecological entities, and these great hills in Houghton Township, and particularly the dunes on Long Point to the east, are dependent upon their vegetation being undisturbed for their very existence. It is for this reason that the sand dunes on Long Point must be protected from large numbers of tourists, and even from groups of careless scientists. The damaging of the vegetation on one of these dunes, even though the plant cover may appear to be very sparse at best, can lead to the complete destruction of this particular part of the sandspit, through the relentless action of wind and water. A good example of preservation of this kind of

landscape is a portion of Island Beach State Park in New Jersey which has been set aside as an ecological preserve. Here the vegetation of the sand dunes is considered to be so essential to the preservation of the entire area that even ecologists are permitted access to particular dunes or plant associations only on temporarily laid boardwalk structures.

Many of the sand dune plants of the Lake Erie shoreline are the same salt resistant species of the Canadian coastal beaches. Several other dune species are able to inhabit the alkali flats of the Canadian and United States prairies also. The grass species are particularly important in protecting dunes from wind and water erosion. The following list contains plants which are found on hills and high dunes of sand, both in Houghton Township and on Long Point.

Figure 12-3/This aerial view of the Backus Woods is the largest remnant stand of forest in southern Ontario. It should be preserved as an ecological area.

Salsola kalii	Common saltwort
Salsola kalii var. *tenuifolia*	Russian thistle
Cakile edentula	Sea rocket
Euphorbia polygonifolia	Seaside spurge
Cenchrus longispinus	Sandbur
Xanthium pensylvanicum	Cocklebur
Artemesia caudata	Wormwood
Cycloloma atriplicifolia	Winged pigweed
Panicum virgatum	Switchgrass
Panicum lanuginosum	Downy switchgrass
Calamagrostis canadensis	Bluejoint reed grass
Ammophila breviligulata	American beach grass
Andropogon scoparius	Beard grass
Andropogon gerardii	Bluestem beard grass
Elymus canadensis	Stout nodding wild rye
Sporobolus cryptandrus	Sand dropseed

) The Lake Erie Marshes

The prevailing winds over Lake Erie are from the southwest. An examination of a map of southern Ontario reveals the smooth, well scoured shoreline to the west of Long Point in Norfolk County. The point itself arises in the area of Port Rowan and Port Royal on the mainland and extends, as a sandspit, for a distance of some 20 miles into the lake. As the winds and waves pass the tip of Long Point a strong counter-clockwise circulation of water is set up in the Outer Bay, known also as Long Point Bay. *Three interesting phenomena result from this circulation of water.* In the first place, the water velocity slows continuously around the periphery of Long Point Bay, due to the frictional forces between water and shores and beaches. Sand, silt, and organic matter are deposited by the slowing waters, resulting in the building of the humus-rich marshes of Turkey Point on the mainland and of Pottohawk Point on Long Point. A second noteworthy outcome of the circulation pattern of the landward side of Long Point is that sand and silt are being continuously deposited along the Point itself, resulting in a steady increase in both the breadth and the length of the sand spit. Thirdly, on occasion because of the shape and relationship of Turkey Point on the mainland and Pottohawk Point on Long Point, the counter-clockwise circulation of the water in the Outer Bay may result in a clockwise circulation within the Inner Bay. Under these conditions, the water follows a figure 8 pattern. The water velocity is of course never great within the Inner Bay, and here warm, shallow marshes support a particularly rich and interesting collection of plants and animal species.

John Macoun in 1892, while travelling west from Niagara to Chatham and Windsor, discovered the station for the American lotus, *Nelumbo lutea,* in the marsh near Port Rowan. This very impressive large yellow-flowered relative of the waterlily occurs in Canada only in a few favored spots in Lake Erie and Lake St. Clair. In the deeper water *at the outer margins of the lake marshes* we find such plants as:

Scirpus americanus	Chair-maker's rush
Scirpus validus	Great bulrush
Zizania aquatica	Wild rice

The latter 2 species grow tall, and often stand well above the water.

In the more open areas of the marshes we find the following aquatic species:

Potamogeton gramineus	Grassy pondweed
Sagittaria rigida	Stiff arrowhead
Elodea canadensis	Waterweed
Vallisneria americana	Tapegrass
Potamogeton richardsonii	Redhead pondweed
Pontederia cordata	Pickerel weed
Cetatophyllum echinatum	Prickly hornwort
Heteranthera dubia	Water star grass
Utricularia minor	Small bladderwort
Nelumbo lutea	American lotus
Ranunculus flabellaris	Yellow water-crowfoot
Potamogeton amplifolius	Large-leaved pondweed
Myriophyllum exalbescens	Water milfoil
Ranunculus trichophyllus	White water-crowfoot
Utricularia vulgaris	Common bladderwort

At the *inner margins of these shore marshes* the water becomes very shallow, and it is frequently possible to walk upon the turfy clumps or tussocks which have formed slowly through the decay of plant material, chiefly of reed grass and cattail. Common herbaceous species of the richest soils of the inner marshes include the following:

Osmunda regalis	Royal fern
Sagittaria latifolia	Broad-leaf arrowhead
Zizania aquatica	Wild rice
Scirpus cyperinus	Wool grass
Caltha palustris	Calla lily
Impatiens capensis	Spotted touch-me-not
Cicuta maculata	Spotted cowbane
Asclepias incarnata	Swamp milkweed
Canvolvulus sepium	Hedge bindweed
Teucrium canadense	Germander
Eupatorium perfoliatum	Boneset
Aster lateriflorus	Swamp aster
Bidens coronata	Tickseed sunflower
Cirsium muticum	Swamp thistle

The reasons for the preservation of these unique plant associations of the Haldimand-Norfolk area are discussed below in the section "Landscape Analysis".

Vegetation

The major vegetational features of the Study Area occur, for the most part, in conjunction with water and wetland features, reinforcing them visually. They are found primarily in the large swamplands of Canborough, Burford and Oakland, in the Grand River valley, in the stream valleys of the Big and Otter Creeks, in afforested areas near Normandale and in the Tuscarora Indian Reserve. Vegetational patterns of smaller scale, but of no less significance occur throughout the Study Area and are manifested in the form of tree-lined county roads, windbreaks, farm woodlots, county and conservation authority forests, provincial parks and private and public reforestation and afforestation projects. Very few of the vegetational features of the Study Area are significant alone, but their importance is highly accentuated when reinforced by other natural features and with manmade elements of the landscape.

Vegetation in the Study Area provides *landscape amenity* and variety where these factors would otherwise be lacking. The effects are:

1) Reduction of the immense scale of large open plains;
2) Containment and filtered views;
3) Reinforcement of the ecological functions of swamplands;
4) Provision of food and shelter for wildlife.

Major Forests

Major forest lands are found in the large swamps of Burford and Oakland discussed earlier under "Wetland". The visual amenity is not strong in this area but the ecological balance of these water catchment areas and stream sources is enhanced by the vegetational cover. The Canborough Swamp presents a similar situation, although the forest cover also provides a welcome relief from the flat clay plain and also provides esthetic effects of color and smell of a type not found in the clay plain landscape.

The Moulton Swamp has been designated by the Ontario Department of Lands and Forests as a forestry use area. This 3000-acre tract of lowland directly south of, and adjacent to, the old Welland Feeder Canal is heavily wooded. Although the quality of forest is fairly low, advantages exist in the form of relief from the flat and uninteresting topography and the factors of

ecological balance, including wildlife habitat. Another large tract of forested wetland occurs northwest of Dunnville.

Certain areas of the Grand River valley are heavily wooded, especially north and south of Brantford. The view of the river from Highway 54 could be enhanced by selective thinning of some of the heavy forest cover. Further south toward Dunnville, willows line the banks of the Grand River, providing a rich pastoral setting of quiet water and shaded banks. Some areas of the Grand River valley are virtually devoid of vegetation and provide very little relief from the adjacent clay plain.

The deeply cut V-shaped stream valleys of Norfolk County are generally heavily forested with hardwoods and conifers. Sharp visual contrasts occur where tobacco fields appear to be carved out of the forests most frequently found adjacent to stream valleys. These woodlands provide excellent scenic backdrops for the sand plain and also present interesting filtered and directed views of the valleys. The contrast from the open sand plain is dramatic; sunlight and heat is contrasted by shade and cool forest air in summer; shelter is afforded from cold and wind-blown snow in winter. The Black Creek valley is forested with heavy pine cover, providing a strong visual contrast with the agricultural croplands.

Reforestation is extensive near Turkey Point at St. Williams and in many locations in the sand plain. While not indigenous to the area the heavy, deep green pine cover forms an exciting backdrop to the agricultural landscape in all seasons of the year. Ecologically, however, it tends to limit the potential of the natural landscape in many ways. Wildlife does not find a wide range of cover or food in these areas; the recreational potential is fairly low because of the low visual interest within the afforested areas where natural vegetational cover with its colors, textures, and patterns is stifled by heavy shade.

Much of the Tuscarora Indian Reserve is heavily wooded. It is characterized by softwoods, associated with the lowland nature of the reserve, which are nonetheless an important visual amenity of the area. Awareness of heavy forest cover is felt here and enhanced by the small clearings in the small-scale Indian settlements.

Minor Vegetation

Minor vegetational features are of great significance in the Study Area. The farm woodlots which occur in many areas of Haldimand and Norfolk Counties form an important rhythmic visual pattern. As viewed from the road they reinforce boundaries of farms, providing recognizable scale to the flat countryside and compensate for lack of interesting topography in many cases. These woodlot patterns are strongest west of Dunnville and in the tobacco areas. In the clay plain the woodlots tend to delineate the rear concession lines of the farms and impart a sense of scale for the traveler in an otherwise "endless" and uninteresting landscape. In the sand plain, the wooded areas are associated with stream valleys increasing the interest impact of this landform, or they may be scattered throughout the landscape.

Windbreaks and hedgerows accomplish much of the same effect as do the woodlots. They provide much needed scale, perspective, contrast and visual interest; but they are also important as a physical characteristic of the landscape personality of this region. In some cases, such as east of Simcoe, the fence rows and farmstead plantings are the only visual landscape stimuli in the area. The conservation and further addition of these elements of amenity are therefore most important to both urban and rural residents of the area and to travelers as well.

The tree-lined roads of the Brantford-Norwich-Burgessville landscape, the area north of the Grand River, Brantford Township south of the Grand River, and the landscape east of Dunnville provide canopies or partial canopies over many of the sideroads. Arcades of trees along rural frontages delineate property boundaries and croplands and are characteristic of these landscapes.

Tree cover along many of the streams with low profile of the clay plains, such as the McKenzie and Boston Creeks, contributes to the recreational potential, landscape amenity and erosion control of these stream valleys.

With the exception of the Turkey Point area, the Lake Erie shoreline lacks major forested areas. Vegetational cover restricts views of the beaches and the lowlands to the north in a few instances near Mohawk Point. The appreciation of high landforms, such as the till moraine at Mohawk Point is negated by dense growth of beech, maple and hickory. In contrast to this phenomenon landscape quality benefits by the reinforcement of the topographical feature with heavy vegetation. The deep, wooded ravines in Norfolk County are an important visual amenity, especially between Port Dover and Long Point.

Afforested Areas

Afforestation in the Study Area has been accomplished through the formation of provincial, county and conservation authority forests. There are approximately 27 county forests ranging in size from 10 to 200 acres. Few of these are used for recreational purposes. Of the nine conservation authority forests, none is used for recreation, although there are approximately 11 conservation areas or parks which provide varying degrees of facilities and potential for recreation. The five provincial parks range from those rich in vegetation, such as Turkey Point, to those lacking in this natural feature as at Rock Point.

Unique Vegetation

The most important unique vegetational features include the Backus Woods, the dune lands of Long Point, and the marshes at Long Point and Turkey Point; their floristic composition and importance has been described above. From the perceptual point of view, the importance of the Backus Woods is the opportunity it offers for the sensory experience of a kind associated with a primeval forest only, a feature which is almost non-existent in southern Ontario. The vegetation of the Long Point dune lands is particularly strong in visual terms as it exists in contrast to an

Figure 12-4/This black walnut plantation near Lyndock indicates potential for multiple use of vegetation stands for recreation, soil and water conservation and timber production. Many plantations of conifers are characteristic of the Norfolk sand plain.

unusual land form and a matrix of sand; its vulnerability to human destruction gives it another precious dimension warranting its preservation in its present form. The endlessness and feeling of a peculiar form of solitude characterizing the marshes make them an important landscape feature to be preserved in a rapidly urbanizing society.

The walnut grove at Lyndock is an afforested stand of mature black walnut trees on the Big Creek floodplain beside the highway. No active use is made of this attractive and potentially valuable site.

History and Culture

The historical and cultural development of Haldimand, Norfolk and Brant Counties is closely related although it is not readily discernible. There are instances of historic buildings and landscapes but very little has been done to exploit these resources for recreational and interpretive purposes.

The major visible signs of the history are manifested in the street pattern and architecture of small villages. Historical landscapes are susceptible to damage, although a few, such as the Dunnville-Welland area with the old Feeder Canal, highway and vegetational pattern, still exist in places. Evidence of cultural resources is found among certain ethnic groups and is manifested in modes of travel, food, costume and cultural organizations.

Historical Architecture

Several locations in the Study Area exhibit a concentration of historical architecture and landscape. The village of *Vittoria,* 150 years old, retains an unusually rich and significant architectural character including churches, homes and commercial buildings; the original layout appears to have remained virtually unchanged. The village, situated in the township of Charlotteville, was one of the earliest village sites in the County of Norfolk. It was designated as the seat of the courts for the London District in 1815 which naturally increased its future growth potential. In addition, to the east of the village there were excellent mill sites which had been developed at the beginning of

settlement. It also had the added advantage of being at the crossroads of several of the most traveled roads in the area. It was therefore a natural center for judicial, commercial, industrial and residential growth.

As the years passed, Vittoria lost its governmental advantages, first in 1826 when the courts for the London District were re-located at the Forks-of-the-Thames, and in 1837 when the area became designated as part of the Talbot District and the Administrative center was located in Simcoe. The Division Court, however, remained in Vittoria and the Township Hall was built there after the Township of Charlotteville was incorporated in 1849. Today, in spite of changing economic conditions, Vittoria still contains a very fine concentration of impressive mid-19th century buildings. The nucleus of this early village is centered at the junction of Brock and Lamport Streets and contains the Anglican and Presbyterian (now United) Churches, c.1845, the Baptist Church, c.1851, the Town Hall, c.1870, a store and several substantial brick and frame houses.

The town of *Paris* is rich in historical architecture, especially of a commercial nature. The historical development of the Grand River valley can be readily expressed, if economically feasible, through public use and continued industry in the numerous mills (especially the woolen mills), churches, homes, stores and hotels. These historically significant architectural features are situated in the picturesque Grand River valley and have the potential for a unique historical experience of regional significance. It is worth noting that in comparison to those in other Ontario towns, the buildings in Paris present a well preserved and maintained appearance.

The city of *Brantford* is also richly endowed with historical resources. Many are closely related to those of the Mohawk Indians, such as the Mohawk Institute; other resources include the oldest Protestant church in Ontario, the Bell Museum and homestead, and the Ontario School for the Blind. Numerous homes of historical importance, and new buildings of outstanding quality, such as the City Hall, are located here. An extensive and comprehensive cataloguing of significant buildings and landscape features is needed to relate the history and culture of the Indians and whites. There is significant potential for exploiting the exciting character of this city.

A major collection of significant architectural history is located in *Waterford.* Although more recent than some of the historical buildings, many homes and churches in Waterford are of architectural merit; these are enhanced by attractive tree-lined streets and an impressive entrance to the town from the south. In conjunction with the water-filled pits to the northwest, these significant streets could be conserved to enhance a historical, cultural and recreational environment here which would well serve as an example to other towns in the Study Area.

The town of *Simcoe* has similar characteristics, although more refined and developed than those of Waterford. Simcoe's unique character, with its regionally outstanding downtown park and its fine homes, should be conserved and enhanced through similar development of the fringe areas and a more pleasing downtown core. Judicious care and long-range highway planning on the part of civic bodies and highways departments in the Study Area must be exercised to avoid damage to civic resources such as already apparent in Simcoe.

A number of *museums* in the Study Area contain concentrations of architectural history and artifacts of regional significance. Some of these are operating mills, such as the Backus Mill. The Bell Museum and homestead, mentioned earlier, are well patronized by tourists.

Historical Landscapes

Although historical landscapes are more difficult to conserve or preserve than historical architecture, a number of landscapes exist today through which the past can be seen. With the exception of the Tuscarora Indian Reserve, none of these has been exploited for public use through education and recreation. The Reserve landscape, although logged at one time, is the only large land tract in the Study Area that has retained much of its original landscape character. The large areas of lowland bush with small Indian settlements such as Ohsweken, and the "village" which is the site of the annual fair relate the history of the Mohawks through the landscape. The potential for larger and more significant restoration and festivals could bring a most important element of recreation through history to the Study Area.

The abandoned *Welland Feeder Canal,* the concrete highway at Stromness, related historical architecture and an old cheese factory near Dunnville possess great potential as historical features for recreation. Railways, canals and highways of the Study Area have all played a significant role in its history and development but only Dunnville contains examples of *all* these historical resources. The establishment of a transportation museum should be considered here.

Five historical land tracts along the Grand River are distinguishable historical landscapes. The Fradenburg, Huff, Jones, Young and River Range tracts are identifiable through their road patterns and settlements on the Grand River. The saga of the Grand River corridor could be interpreted from these landscapes for educational and recreational purposes.

Cultural Resources

The accompanying table gives an indication of the ethnic cultural resources as presented in the 1961 Census of Canada. The clearest evidence of these major resources is concentrated in the town of Delhi, in the Tuscarora Indian Reserve and in two Mennonite settlements. Restaurants at Delhi offer German, Polish, Ukrainian and Hungarian foods. Various ethnic clubs also exist here. With further attention, the clubs and restaurants could become a much more identifiable ethnic expression; festivals, costume and dance traditions should be considered as a means to realize the existing potential.

The historical architectural and landscape resources of the Tuscarora Indian Reserve are not very different

from those in other rural parts of the Study Area. However, the "Indian Village", the annual Indian festival, handicrafts and fairgrounds have potential to form the basis of an expanded and unique cultural heritage and ethnic expression.

The two Mennonite communities, east of Mount Elgin and west of Aylmer, are readily recognizable through the farm patterns, modes of dress and transportation. Although these communities are small, their significance should be recognized and the preservation of their character encouraged.

As outlined in Chapter 1, Historical Background, the development of Haldimand and Norfolk Counties owes a great deal to the United Empire Loyalists and the Americans that followed them. Many of the small communities in the Study Area were founded by Loyalists. Some of these, such as Port Ryerse and York, should be recognized as U.E.L. settlements, offering interpretive facilities and programs through conservation, restoration or reconstruction of features of cultural heritage. By their names, numerous villages and streets give evidence of early Loyalist and Indian settlement and activity.

Many isolated examples of *architectural relics* are found in the Study Area. These include the old cheese factory near Dunnville mentioned above, Senator McCallum's home, numerous mills, the Adelaide Hoodless home, the glass factory ruins at Dry Lake and the Pauline Johnson home on the Grand River. Some have been restored and are now museums. Unfortunately, a great many others have been allowed to deteriorate and this heritage will soon be lost not only to the residents of the region but to Ontario and Canada.

The Brant Historical Society has identified Ruthven, the Thompson home just above Cayuga, built during the Canal Period of the Grand River, as the finest surviving stone house in the Grand River valley. It has recommended that this structure and surrounding lands be set aside as the "Sir Frederick Haldimand National Historic Park" in honor of this history maker of the early Niagara period.

Many of these potential architectural resources noted above should be restored for conventional public visitation while others might form the nuclei of recreational open space within the towns and villages. Still others, larger in scale, could become exciting features of interest within the natural environmental corridors of the Study Area; one of these with significant potential is the original Fort Norfolk, now simply identified with a historic marker.

The *fishing ports* of Port Burwell, Port Maitland, Port Dover and others are already tourist and recreation attractions. They have further potential for development as examples of important commercial enterprises of long standing.

The numerous dams of the Grand River and other streams are further examples of significant historical relics which have development potential for recreational and educational purposes within the major environmental corridors of the Study Area.

Cultural features of a minor nature occurring as isolated resources include numerous fairgrounds, farmers' markets, the RCMP Barracks at Ohsweken and the Ontario Agricultural Research Station. These could be exploited in a fashion similar to the historical architectural and landscape resources noted earlier.

The resources identified here and their development potential should not by any means be considered a complete inventory. Rather, they illustrate that a rich and diverse cultural heritage exists in the area but requires further detailed study and early conservation measures. It is important that the residents of the area be engaged to conduct a systematic inventory program with cooperation and subsidy as required from local groups, the Architectural Conservency of Ontario and local and provincial governments. The efforts of the Norfolk County University Women's Club could well be emulated as a systematic example and productive effort in this field.

Archaeology

According to Professor William M. Hurley of the Department of Anthropolgy, University of Toronto, no detailed archaeological survey has been done in the Study Area. However, he did do some work in the Norwich area in 1969 on remains of an early civilization probably tied to the beginning of the Ontario Iroquois traditions — an Early Western branch known as the Glen Meyer. This is the first of the Glen Meyer sites, covering the period from 1000 to 1300 A.D., to be excavated. Prior to this time, from 3000 B.C. to 1 B.C., Indians visited the area on hunting expeditions only. Following this period, however, there was occupation by the Midland Woodland people who were succeeded by the Iroquois and their stockaded villages.

The only possible archaeological site found by the authors of this chapter are mounds thought to be Indian graves. These are located in the Deer Creek valley above the new dam, but as no digging has been done there is no evidence that they are Indian graves.

Professor Hurley recommends that an exploration program be undertaken to gain knowledge of early peoples of this area and their relationship to the Late Woodlands (Algonkin) peoples in Michigan.

Wildlife

Because most of the Study Area has been cleared for agriculture, wildlife is seldom seen. The few major concentrations occur in and near the large marshes. Small populations of game animals and birds are found in the remnant woodlots, especially in the deep wooded valleys of Norfolk County.

A major concentration of wild ducks is found at Turkey Point and Long Point Marshes. The strategic value of these areas as habitat for reproducing and migrating birds of many species is discussed in Chapter 9 Wildlife Resources. At present both marshes are under private ownership and are used as hunting preserves. The bag taken is far below the capacity.

A deer population of approximately 1000 is found at Long Point which should support about 200 animals. The overpopulation has resulted from the extinction of wolves in this area through bounty hunting. Several wolves are said to exist here but the large

number of deer is causing a shortage of food and preventing forest growth. The overgrazing which prevents new growth has resulted in an interesting pastoral landscape; the deciduous trees are almost bare from 6 to 8 feet above the ground.

The private lands of the Turkey Point Company also serve as breeding grounds for large numbers of pheasant. Adequate population for limited hunting exists with the present management.

Small populations of small game and forest animals exist in the wooded valleys of Norfolk County and in the Tuscarora Indian Reserve. Rabbits, skunks, squirrels, porcupines and chipmunks as well as many songbirds were sighted in these valleys. A few otters were also sighted in the Deer Creek valley. Muskrat and beaver are found in the swamplands of the Study Area.

Some unique potentials for game and hunting preserves exist in the Study Area, the marshes of Turkey Point and Long Point being prime examples. In some cases restocking of animals which have been killed off may provide new wildlife populations with appropriate management techniques. The possibility of restocking Long Point with wolves to reduce and manage the deer population is one example of this technique.

Pollution

Pollution was detected in all its forms — visual,[9] auditory, tactile and olfactory. While air, water, soil and visual pollution are interrelated they have been separated for the purpose of this inventory.

Air Pollution

Air pollution at the Electric Reduction Company (ERCO) plant at Port Maitland is readily apparent adjacent to the plant and up to several miles from it. A fine greyish white dust lies on the entire landscape near the plant; vegetation is stunted or dying and the area presents an acutely depressed appearance. The only occurrence of apparently significant *noise pollution* was also detected at the ERCO plant, a dull rumble being audible as far away as one-half mile.

The urban centers within the Study Area are not plagued by air pollution, probably due to their small size and limited industrial activity. Very real potential exists, however, in such prospective major operations as the Ontario Hydro generating station and the proposed Stelco, Texaco and Dofasco plants. Urban and traffic growth accompanying industrial activity hold every prospect of air and noise pollution as well.

Water Pollution

Along the Lake Erie shoreline rotting algae and dead fish are visible, accompanied by noxious odors, significantly reducing the quality of recreational experience and potential. An oily scum at Mohawk Lake in Brantford prevents swimming and makes even canoeing inadvisable. Abutted on two sides by city park, the potential of this water body is dramatically decreased by pollution.

Visual Pollution

Refuse dumps, offensive commercial signs and billboards, abandoned buildings and derelict landscape, and existing abandoned diggings and gravel pits are all part of existing visual pollution. Discarded tin cans, cars, furniture, appliances and industrial wastes are found at the outskirts of almost every town and village. Visual, air and water pollution committed by the town of Waterford through the dumping, filling and burning of garbage in an attractive water-filled quarry is much to be deplored. On the other hand, similar quarries have been developed directly across the road as excellent recreation areas for swimming, camping and picnicking.

Natural water bodies such as Dry Lake are being filled with industrial waste and trash, to the serious detriment of the recreational potential and wild bird population. Illegal dumping along sideroads exists throughout the Study Area.

A major form of visual pollution is the jungle of commercial signs and billboards in the approaches to towns. Commercial signs are the most evident. In unique and picturesque urban areas,

Figure 12-5/This example at Waterford of dumping and burning garbage in a water body is evidence of desecration of an important recreational landscape feature. It contributes to air pollution and contaminates groundwater supplies.

such as Vittoria and Vienna, only one garish sign could destroy the character. The approaches to Port Dover, Port Maitland, Turkey Point and Long Point are cluttered by a profusion of billboards and signs. Uniformity and order in design through improved graphics and messages could overcome part of the offensive nature of some advertising. Although the conservation authority signs are rather unimaginative in design, they are consistent, readable and communicate their message well.

Abandoned and deteriorated cottages near the Mohawk Point Conservation Area and at the Port Burwell beach are offensive, especially considering that they are located near areas of high natural amenity on the lakeshore. Lack of control of this type of development has obviously permitted such a low standard of construction and maintenance that the cottages were ultimately abandoned.

Abandoned surface mining operations such as gravel excavations and stock-piled overburden and waste

are a significant source of visual pollution in the Study Area. When used for dumping grounds, the pollution problem is compounded.

Pre-planned mining operations, controlled cottage development, planned and controlled dumping grounds and control of outdoor advertising should be a major objective in achieving better environmental quality throughout the Study Area. Government regulations at all levels regarding air and water pollution must be enforced and strengthened for future environmental protection.

Urban Quality

As there is no large-scale urban expansion in the Study Area there are no settlements which have lost their identity as a result of suburban growth. However, there are instances where growth is resulting in marked change in scale, space and style of urban structure. Where growth has occurred to a significant degree, the old and the new areas tend to be separate.

With the exception of Simcoe, Tillsonburg, Paris, Dunnville and Brantford, the urban settlements appear to be agricultural service centers much as they were when founded. Settlements of this type have several common characteristics. They are always located at the intersection of two roads, which become the main streets of the central business district. Few new structures have been built in the original parts of towns, the old stone and brick structures having been adapted and remodeled to accommodate new activities. There are many instances of remodeling which have detracted from the original character and architectural style. In most of these cases, however, the original building has remained and their facades could be recovered.

The town of Cayuga is a good example of organic growth with buildings in the period styles and local materials. The large bank, town hall and post office, and two-storey row housing remain as the dominant buildings of the town. Dunnville is another example of the four-corner type of development with the major buildings, the hotel and banks still in use. These towns and many of the smaller ones are typified by treeless commercial streets and tree-arcaded residential streets.

New construction is characterized by wider streets, larger lots and single-storey housing. In all instances it is a direct out-growth from the core area along access roads.

Because of parking space needs, some towns have established small convenience shopping plazas and liquor and beer retail stores outside the downtown area. Thus, undesirable decentralization of the commercial areas has begun in such towns as Burford and Caledonia.

One of the major differences readily evident between the old towns and their newer parts is the construction materials used. The original buildings were constructed of indigenous materials. New technology has made available use of diverse "universal" materials in different forms including aluminum, steel and a wide variety of natural and artificial stone and brick. The towns, therefore, are unable to maintain, or to develop, a distinctive personality or character and the new construction tends to be monotonously similar throughout the entire Study Area. On the other hand, the original parts of towns like Jarvis, Waterford and St. Williams have distinctive architectural styles and materials. Jarvis is marked by several original square, red brick houses with yellow brick trim. Houses at St. Williams are almost exclusively of frame construction of similar type and style.

All areas of settlement suffer from automobile congestion which entirely dominates their commercial areas. Only Brantford has a sufficiently differentiated hierarchy of street use to afford major truck routes off the main downtown streets. Residents of Simcoe questioned the merit of widening an approach route which destroyed neighborhood quality. One of the approach roads to Waterford is densely lined with a long strip of new residences of high quality which should not have been permitted in such an unplanned, indiscriminate manner.

Because all settlements developed with relation to communication-transportation routes, the present cross-roads location of key activity patterns is understandable. But, in terms of today's mobility and parking demands, more rational arrangements should be used for residential development. Caledonia has located a large area of housing across the Grand River taking advantage of the river as a focus and the valley bank as a natural site feature. In many areas of settlement, a more sensitive adaptation to natural features should be adopted as a policy for new residential developments. The town of Paris, which has distinct upper and lower towns, has taken advantage of opportunities across the Grand River valley for its new residential areas. But many towns are not oriented to major and dramatic natural features. Dunnville and Brantford are examples of settlements which have turned their focus away from the river; visitors can call on both towns without being at all aware of the Grand River. In many cases the industrial developments make access to the river difficult and unpleasant. As many industries with river frontage do not now require water for operation, a long-range policy for their relocation should be developed. Nothing short of this kind of policy will restore the views of the region's towns to the prominence they deserve in creating amenity, civic pride, stability and environmental quality in general.

Simcoe is an example of a town which has recognized the potential of a modest stream, manipulating the water and surrounding open space into an outstanding civic focal point which should be emulated as a model for all other urban centers in the Study Area.

Tillsonburg has not taken advantage of the deep valleys that could give character to the town; Delhi, on the other hand, has recognized the natural beauty of the wooded valley through development of a conservation dam for fishing and irrigation and the creation of a picnic site and park. In this way the entire valley has been made a primary focus for residential development.

The lakeshore settlements have a natural water orientation physically and in terms of activity ranging from fishing

and commercial activities to recreation. However, their layout does not recognize these activities. Port Dover has developed an amusement area which shows no planning recognizing natural features and compatible and complementary uses. The activity generated by holidaying crowds is exciting but it has not been consciously or carefully planned as part of the activity of both the town and the fishing port — to the detriment of the economic well-being of the town and the recreational experience of vacationers.

The town of Paris is undoubtedly the most interesting and picturesque because of the river valley setting and the high quality of commercial, industrial and religious structures. Brantford is the only center where a conscientious program of downtown reorganization seems to have been undertaken; a new image is being created with the new city hall. This impetus should be extended to create a continuous open space along the river connected to the city core. The cleaning up of the edge of Mohawk Lake can provide a natural in-town feature as a focus for open space related to high density development.

A number of towns are not showing signs of progress. In the case of Port Burwell the increase in unplanned trailer developments appears to be creating an atmosphere of instability. Seriously deteriorated cottage and recreational developments detract from an otherwise attractive beach environment close to the central area. It is doubtful that these, as well as other similar developments, meet standard building and health codes. A new aspect could come to Port Burwell with development of quality intensive recreation facilities. Due to its river mouth location and its good beaches close to the commercial area, it is well suited to become one of the choicest lakefront towns integrated with recreation uses.

Vienna is a river valley settlement of pleasant, intimate scale. The original character of stores with front porches and oiled wooden floors would be quickly destroyed if incompatible architectural styles were built next door. Scotland is similar; the stone buildings and narrow through roads remain. However, these towns also show the usual signs of change — widened approach roads with accompanying destruction of the maple arcade and some new residential construction of non-indigenous material and incompatible style. Long-range highway planning policy should be examined to avoid or minimize destruction of this existing urban quality.

Urban renewal to serve growing and changing service needs is not incompatible with the preservation of valuable architectural heritage. Renovation and expansion can be accomplished in good taste as has been demonstrated in other Ontario towns.

Landscape Personality

As indicated earlier in this chapter, rebional landscape amenity is of central importance to the environmental quality of a region. This amenity is derived not only from the smallest of landscape constituents but from groupings of these constituents to give contrast, that basic sensory quality which makes the region an interesting and exciting place in which to live. Landscape personality as defined here is that combination of physiography and vegetation which imparts a particular or discrete character to land areas which may vary considerably in size. While usually only natural features are considered manmade features were considered here in view of their frequency and prominence.

Field analysis revealed seven distinct landscape personalities which include the following (see Map 12-5):

1) The Lake Erie shoreline.
2) The Grand River valley.
3) The clay plain extending east of the Grand River valley to the Canborough Swamp and west of the river to Jarvis.
4) The varied topographical area from north of Brantford to the Norwich-Burgessville line.
5) The Big Otter and Big Creek valleys and their adjacent uplands.
6) The area south of the Norwich-Burgessville line, lying between the clay plain and Big Creek valley (transitional zone).
7) The Long Point spit.

The Lake Erie Shoreline.

The shoreline which derives its strong visual cohesiveness from the large water body, is perhaps the most significant landscape personality of the entire Study Area. This strong natural feature is therefore the setting for the most extensive recreational developments in the Haldimand-Norfolk region. While the lake is obviously an extensive recreational amenity, much of the natural character of the shorelands is not of high recreational capability. This may explain why relatively little of the shoreline is developed, as contrasted to the Lake Ontario and Lake Huron shorelines.

The lakeshore personality does not

appear as a continuous unit because of the difficulty of access and because of the scattered various types of development. Rather, the personality is one of a series of experiences, from the excellent beach at Port Burwell (marred by conflicting uses of recreation and industry) to the rocky eroded beach at Mohawk Point. Between are exciting and interesting nodes of natural and manmade features, such as Long Point, Turkey Point, Port Dover, Port Ryerse, Peacock Point, Byng Island and Port Maitland. Only at these nodes of development is the individual brought down to the water to appreciate at first hand not only the water, but the activities related to it.

The general visual experience of the lakeshore personality is one of wide open spaces, flatness and agricultural crop production. Large acreages of corn, tobacco and orchards have a visually pleasing impact. Generally, the shore edge at the brow of the cliffs is very flat and lacking in significant interest. The only visual contrast and quality of landscape is evident at the mouths of the various streams and rivers that empty into Lake Erie. An overview of the lake or a dip through a river valley then becomes a very important element in the visual experience of relating to the lakeshore and the lake.

There is a great deal of potential for creating a pleasanter experience related to the water through re-alignment of existing rights-of-way and creation of new scenic rights-of-way near and adjacent to the lakeshore. Highway 3 which roughly parallels the lakeshore is heavily traveled by tourists. Unfortunately, the lack of visual access to the water tends to create a dull and lackluster trip for the tourist and resident alike. As a result, this highway is simply a shortcut from Detroit to Buffalo for many travelers, its potential tourist recreation market remaining relatively untapped.

Natural Features. The natural features along the lakeshore which contribute to its personality are actually few. Two major natural features, however, warrant serious consideration: Turkey Point, with its fine beach, forest cover and interesting marsh area; and Long Point, with its fine beaches, marsh areas and unique delicate sand dunes.

Other smaller nodes are of value mainly because of their visual contrast to an otherwise monotonous lakeshore. The mouths of the larger streams and their valleys are of special significance in this respect, and the afforested areas near Normandale are also of value. The sand hills near Port Burwell, too, are of major significance in the flat landscape of the lakeshore.

Manmade Features. Manmade features along the lakeshore contribute to its personality in limited, but significant ways. Some of these manmade features are worthwhile attractions, whereas others are serious detractions. The important features in this category are mainly the small fishing villages. Some are picturesque and exciting not only for the fishing activity but for the other activities they generate. Others which are abandoned or in a state of disrepair are of historical interest. The bustle and activity of Port Dover with its fine sand beach and midway atmosphere is an example of the former manmade attraction. The quiet, wooded serenity of Port Ryerse on the other hand is an example of the latter, as is the small intimate fishing village of Port Maitland.

Reinforcing the manmade features are a number of recreational areas, and conservation authority, provincial and private parks. Rock House Point, Byng Island, Selkirk Park, Normandale, Turkey Point, Booth's Harbour, Long Point, the Sand Hills and Iroquois Beach (Port Burwell) are examples. Because many are new not all have realized their potential. Some are of low quality and might be more useful with improved design and greater investment in maintenance.

Probably the most significant manmade feature along the lakeshore is the cottage development. Generally, it does not consist of patterns of major concentration but tends to consist of strip development, often closing public access to the water and beaches or frequently interrupting the view of the water from the road which is often the only public land. Promontories offer the greatest exposure to the amenity of the lake — that is, viewing and active use of the water. Their value is obvious for they were the first to be developed for cottage use, e.g., Peacock Point. This is an unfortunate development; promontories, having a large shoreline exposure in relation to their land area, are well suited for public recreational use. This phenomenon warrants future study in relation to redevelopment of prime shoreline areas.

The quality of cottage development varies from poorly maintained to well organized and maintained; but most of the development appears to be of mediocre quality.

Industrialization. Here lies the biggest threat to the lakeshore personality. The ERCO plant at Port Maitland is a major feature of the manmade lakeshore landscape and can be seen for miles because of the flat topography. It has a profound effect on the entire area because of its massive scale, discharge of pollutants and its transportation service by railways, highways and ships.

The Ontaric Hydro plant with its 650-foot stack and other industrial structures that will be built along the lakeshore will be major contributors to a rapidly changing lakeshore landscape personality. Such structures and activities will precipitate problems not only of economics and air and water pollution, but also those that are visual. These will spawn many more changes, most of them highly detrimental to recreational development. It is therefore advisable to consider very carefully any location for proposed industrial plants along the lakeshore, not only from an economic standpoint, but also for visual and recreational reasons.

Summary. It would appear that the landscape personality denoted as the lakeshore is basically a corridor of flat agricultural landscape of little interest in itself. It is, however, punctuated by contrasting nodes of natural and manmade features which consist of significant unrealized potential for tourism and recreation. The only exception is the well defined corridor of natural amenity from Long Point

through Turkey Point to Port Dover. For the most part, both desirable and undesirable manmade features are concentrated in these nodes.

Optimal, integrated use of the natural and manmade features of the Lake Erie shoreline landscape personality can be realized, but only with careful planning will well defined and integrated patterns of development and land use be achieved.

The major deterrents to recreational use of the shoreline are access, beach quality, and cottage development. Access is limited not only for lack of roads to or near the lakeshore, but because of the high eroding bluffs along which there is little or no usable shoreland. The beach quality is poor for several reasons — the shore is frequently narrow and rocky, and the water polluted. Also, marshes are not suited to high intensity use although they have wildlife oriented recreational value.

There exists a large untapped recreational potential highlighted by the uniqueness of the Houghton Sand Hills, Turkey Point and Long Point, and the river valleys. The water, beaches and cliffs are part of this undeveloped potential.

While water quality, beach quality, erosion and access have been identified as problems, these can be overcome in many cases for a growing user population. Also, conflicting land uses such as coal yards and swimming beaches must be eliminated as part of the overall strategy.

Great potential exists for a controlled-corridor development containing important nodes of urbanization such as fishing and tourist villages and nodes of recreational development such as beaches, boating facilities, campgrounds, golf courses, etc. These nodes could be reinforced by stream valleys at many of these locations, providing natural and manmade amenities peculiar to the Haldimand-Norfolk region and distinctive in the province.

All future development must recognize not only the physical but also the potential legal ramifications of the extensive shoreline erosion described

Figure 12-6/The landscape of the Lake Erie shore varies in terms of width and kind of beach. Also the height of bluffs is variable. In almost all cases, however, the forelands are flat agricultural landscapes interrupted by river valleys and strip cottage development.

in this and other chapters of the report. The problem arises where erosion control works established at one point may cause damage to neighboring property and adjoining water. The common law prohibition must be investigated and, if necessary, English common law with respect to neighboring water should be examined. The certain prospect of large-scale harbor works makes advisable both this kind of study and engineering studies to identify in some detail the local effects of such works. Also effects of these works on large and important landforms such as Turkey and Long Points, which depend upon natural erosional processes, should be carefully studied.

The Grand River Valley.
Smaller in scale than the Lake Erie shoreline the Grand River valley nonetheless is of great significance for recreational potential. It is perhaps the richest of any of the landscape personalities in its historical and cultural features, recreational potential and variety of experiences. The river itself is a major natural amenity the development of which, with the exception of Brantford, Paris and Dunnville, has been very limited. This results partly from the relative inaccessibility of the river, as with the Lake Erie shoreline. The Indian lands, few roads, and marshes and bogs are barriers to access.

The Grand River valley personality, like the Lake Erie shoreline, does not appear to be cohesive, mainly due to the lack of access. Landscape quality however, ranges from the high banks and spectacular views of Paris to the broad valley and expanse of water at Dunnville. In between there are many interesting and potentially valuable features, both natural and manmade.

Natural Features. The natural features along the valley which contribute to its personality are varied and numerous but fall into 3 basic landscapes:
1) the variety of natural relief including the deep valley near Paris.
2) the flatter valley and heavily wooded area adjacent to the Tuscarora Indian Reserve.
3) the broad valley with its marshes near Dunnville.

Figure 12-7/For the most part, the lands on either side of the Grand River are forested and topographical features are gentle.

Other features of smaller scale but great significance are the tree-lined banks occurring in many places, the numerous stream tributaries and the islands in the river.

Manmade Features. In contrast to the Lake Erie shoreline landscape, manmade features of the Grand River valley personality are abundant and provide great development potential which should be exploited to provide a rich landscape for enjoyment. The features lending vitality and significance are found in concentrations along the river and are generally associated with urban areas.

Paris is undoubtedly the most attractive town in a picturesque setting in the entire Study Area. Along the river are historically significant structures and remnants 100 or more years old — dams, grist mills and cotton mills. The railway and highway bridges are engineering accomplishments providing dramatic views of upper and lower Paris. The gravel excavations around Paris provide much unrealized potential for recreational development.

The folklore and intrigue of Indian history is evident from Brantford and through the Tuscarora Reserve. The Johnson House and many examples of the Six Nations culture are found in the river valley and its environs.

Old mill dams at Cayuga and Caledonia provide deep water and picturesque settings for these villages. The abandoned Welland Feeder Canal at Stromness has much historical significance and, in relation to some of the historical buildings, could form an important cultural heritage complex.

The small number of recreation developments do not reflect the potential of the Grand River. For the most part, though, they are pleasing and augur well for more development. Examples are the Byng Island Conservation Park, and the parks in Brantford and Paris. Numerous small private parks are not of great significance but indicate that potential exists. In relation to the upper Grand, this section of the river in the Study Area is sparsely developed.

Cottage development is not a significant manmade feature of this landscape. Small concentrations of cottages are found between York and Dunnville. A few isolated cabins and old mobile homes are found along the river banks in places, but these are of little consequence as yet. Particular cognizance should be taken of strip cottage developments and permanent residential subdivisions occurring on the west side of the river between the river and the road from Cayuga and Dunnville. It is rumored that landowners in this area have plans for much more of this kind of development and future planning should focus on the desirability and quality of such anticipated development.

East of the Grand River just above Dunnville there exist a number of cottages on a narrow strip of land between Highway 54 and the river. Some are of poor quality but a growing number are permanent homes. This development is endangering the potential of this land for such recreational use as a parkway. The width of the land between the highway and the river increases north of here.

Industrialization. Industrial development is limited to the larger urban centers of Paris, Brantford and Dunnville. These developments are noted as visually undesirable, consisting for example, of railways, sheds and general urban clutter in the river valley at Brantford. They are not of large visual significance in the total picture, however as the valley seems relatively untouched as an industrial basin from Brantford to Dunnville. In view of prospective urban growth, future development plans should weigh carefully the landscape quality of the Grand in relation to alternate industrial sites adjacent to the river valley.

Summary. The Grand River valley landscape personality is basically a corridor, the central feature of which is the river; it is a significant feature of the Haldimand County landscape, punctuated by nodes of natural and, particularly, manmade features of large unrealized potential. The river valley is a fairly well defined corridor which lends itself readily to the development of an open-space system linked with the Lake Erie shoreline system. It is rich in historical and water features, the culture of the Six Nations Indians and natural vegetation. The valley corridor

could become one of the most valuable recreation systems in this part of Ontario, servicing the burgeoning population of Brantford, Hamilton, the Golden Triangle and the Niagara Region, as well as tourists who so far have not been aware of its existence.

Generally, the Grand River has continuous visual interest. Views of the river range from those of a high degree of interest to the more placid pastoral scenes. Highway 54, parallelling the east side of the river for much of its length from Brantford to Cayuga, provides some excellent views, creating an awareness of water and a feeling of closeness to it. Opportunities for creation of scenic routes and easements and recreational development of a large part of the valley are extremely obvious from this highway.

The potential of the Grand River for recreational boating will be discussed below.

Figure 12-8/The clay plain landscape is exceedingly flat and visually monotonous. Vegetational features and conventional structures assume greater importance in this area. Large industrial structures require careful design attention, for they can be significant negative factors.

The Clay Plain

Immediately east and west of the Grand River valley the land is distinctively flat, open, deteriorated, agricultural landscape. Outstanding features are the large number of abandoned farms and croplands, and poor crops. The only major transportation route through this landscape is Highway 3. Poorly drained areas, swamps and creeks tend to act as barriers although some offer visual interest. Evidence of poor drainage is seen in ditching networks which are necessary agricultural practice.

Natural Features. The lack of natural contrasting features forms a monotonous landscape, in which railroads, hydro and fence lines, windbreaks and roadside plantings, especially the coniferous, become very significant.

The few elements of natural contrast are the low knolls which have been cleared and are farmed, the Oswego Creek valley and the Canborough Swamp. These natural features are not outstanding and do not provide as great a visual impact as the railroad lines. However, in an area bereft of natural features they do have an important potential because of the lack of other interest in the area.

Oswego Creek follows a meandering course consisting of oxbows, swampy areas and a variety of crossing experiences as a result of different types of bridges. Unfortunately, much of the creek valley has been and still is being pastured and is subject to a high degree of erosion. Policies and guidelines for the development of this relatively unusual natural feature for this area must include measures to eliminate the pasturing of this creek valley and others.

No significant acreages of forest remain with the exception of the Canborough Swamp. A countryside improvement policy to afforest knolls to accentuate topographical relief in an otherwise dull landscape should be considered.

Manmade features. In the clay plain landscape manmade features stand out; the forests have been cleared and the land is used for agricultural and transportation purposes. None of these uses, with the exception of those previously mentioned, have provided any real amenity or pleasing character. The extent of densely settled areas is negligible. The four-corner settlements of Canborough and Fisherville are the only ones of significance. These villages are not experiencing growth or activity. There are almost no recreation facilities within the clay plain. The few areas of potential, other than those previously mentioned, are the old quarries on the western end and Dry Lake, although these are of minor scale.

Summary. The clay plain landscape presents a discouragingly low potential for amenity development. The homogenous visual quality makes it rate very low in terms of priority for amenity development. This problem can be overcome, however, through the application of landscape improvement techniques. Normally insignificant features should be articulated to their full potential and new items of landscape interest created. For example, Oswego Creek, Canborough Swamp, knolls, railway lines, and farmstead plantings should receive landscape treatment to achieve visual relief from the barren flatness and openness of this landscape. Integration with the Grand River valley may also be accomplished through linkages along the streams which flow into the Grand. Additional features such as parks with a range of

recreation facilities might be created, as at Taquanyah Wildlife Conservation Area, as well as local parks.

The Brantford-Norwich-Burgessville Area

The landscape north of Brantford extending to the Norwich-Burgessville line is characterized by a strongly identifiable topography. Although the area is rather extensively farmed, it is distinct from the clay plain and from the Big Otter and Big Creek landscapes as a result of the mixed farming which contributes a variety of agriculturally based experiences. Variety is evident in the natural landscape as well, which includes a number of landforms such as hilltops, ridges and lowlands. Visual appeal and natural and manmade amenities are abundant in this landscape.

Natural features. The varied topography with its views and spatial enclosures is reinforced by natural woodlands which in combination afford a large absorptive capacity for structures and development without destroying the natural landscape character. The hills, hollows and woodlands could provide for visual separation and pollution abatement.

There are many attractive small hills and pockets containing small lakes and ponds. The Blue Lakes are the most significant bodies of water within this area, but they have not been developed for public use. They do, however, have potential for recreational development through public ownership.

A rich variety of visual experiences is afforded by the physiography and vegetation of this landscape. The constant rise and fall of the land gives expectancy in approaching a hilltop or rounding a curve; the hilltops and undulations of land allow a variety of views according to one's vantage point. Hollows restrict sightlines and provide feelings of enclosure and human scale. Hilltops offer unrestricted views of large areas of countryside, especially from the ridges which parallel the marsh areas. The sharp undulations on the landscape often provide a foreground to perspective and large scale to the landscape. Many tree-lined roads also add to the feelings of perspective, distance, enclosure and scale.

Figure 12-9/The Norwich-Burgessville-Brantford landscape is highly interesting in terms of its agricultural character, vegetation and topography. It has high urban absorptive potential.

Manmade Features. On the whole, the manmade features of the landscape have tended to take advantage of and to be in harmony with its natural features. Mixed and dairy farming practices impart a picturesque element to the landscape, many of these farms being most attractive showplaces. Large "country squire" farms, country estates and second homes are beginning to be developed in a fairly large way in this area.

Summary. The Brantford-Norfolk-Burgessville landscape has a distinctive character because of a variety of harmonious natural and manmade features which should be retained and reinforced. The potential for public recreation facilities is not so great as that of the Grand River valley landscape or the Lake Erie shoreline landscape mainly because of the lack of large bodies of water. However, the landscape holds a much different kind of recreational potential — that associated with countryside pleasure driving, scenic views, and development of land-based recreational facilities for activities such as snowmobiling, camping, group oriented activities, etc. Natural corridors formed by the valleys, hollows, marshes and woodlands must be carefully considered so that the existing landscape character may be preserved and future development made consiste with it.

The natural and manmade feature of the landscape attract people to the area, and probably will continue to do so. A comprehensive and detailed policy must be formulated to encourag attractive developments and to discourage those developments not compatible with the relatively pastoral nature of the landscape. This is an important measure in view of the landscape's high development absorption potential.

Big Otter-Big Creek valleys

The two valleys and their related uplands form a landscape of great con trasts and excitement. The visual amenities of this landscape are extremely important, providing the mo exciting contrasts of any landscape in

igure 12-10/Row and orchard crops with dramatic visual backdrops of forest stands, anted or natural, characterize the Norfolk sand plain. Despite its flatness, the agricultural haracter makes it an interesting landscape.

ıe Study Area. This element of strong isual contrast results from the ıxtaposition of the visually flat agri- ultural plain and the steep, heavily ooded creek valleys.

There is as yet little development in ıe areas of highest natural amenity, s in the Grand River valley landscape ıd Lake Erie shoreline landscape, ır the same basic reasons — lack of ccess and probably lack of population essures. This situation has pre- ented destruction of its great potential r quality recreation.

Natural features. In the Big Otter- ig Creek landscape personality these e found mainly in the creek valleys. ıese valleys are generally V-shaped, eep-sided and heavily wooded. rtually unspoiled wilderness charac- rizes these creek valleys and the ainage areas relating to the Big Otter ıd Big Creeks. The natural features ınsisting of trees, water, wildlife and ndform are the best in the inland art of the Study Area.

Water quality is excellent in many ıses and is almost always visually cellent. In some areas the woods ex- ınd beyond the sides of the valleys, but in most cases tree growth extends only to the rim line. One prominent aspect of the heavily wooded valleys is the high quality of the vegetation characterized by hardwoods; walnut growth in particular is of very good quality. Outstanding maturing growths occur here, the quality of which does not exist in the clay plains or in wooded areas elsewhere in the Study Area. The Tuscarora Indian Reserve, although heavily wooded, consists of elm and maple. Other heavily wooded areas are either found primarily in swamps, containing softwoods, or are pine afforestation stands.

The valleys with their wooded sides form linear patterns of predominantly natural landscape which should be developed as recreational corridors through conservation, scenic easements, recreational facilities and scenic highways.

Manmade Features. Fortunately for this landscape the manmade features are an outgrowth of its physiographic character. Windbreaks, afforestation, agricultural practices and organized patterns of development reflect this character strongly.

The most significant manmade influences are the agricultural land use and its related features which tend to stand out in strong contrast to the flat landscape away from the valleys. The architectural character of the farm buildings is simple and organization seems orderly. The tobacco kilns, outbuildings and farmhouses have a quality of unity, and their purpose adds a dimension of harmony with the land-based agricultural industry.

There are few recreational developments in this area and the existing ones have not been developed to their full potential. The Deer Creek Conservation Area, more by happenstance than by design, is well integrated into the natural landscape, and will provide water for boating, fishing, swimming and other land-related uses. Tillsonburg has attempted to use the creek valley for recreation, but only to a token degree. The Lehman Conservation Area, where on the positive side water has been impounded and a fish ladder installed, is accompanied by undesirable effects of poor land use control and shortsighted planning characterized by residential development which has been allowed to encroach on the water body. Also, filling over the banks has been permitted.

Summary. The Big Otter-Big Creek and the clay plain landscapes are basically similar in that they are both flat plains incised by creeks. But the Big Otter-Big Creek area is significantly different from the other in that the type of land use is much more prosperous in appearance and has stronger organizational patterns. Whereas the flat clay plain is largely dull and uninteresting, the flatness of Big Otter-Big Creek landscape is overcome by visually exciting colors and textures of crops, other vegetation and farm architecture. Contrasting elements such as the deep forested valleys, windbreaks and large afforested areas and woodlots add further variety. The differences in visual interest between the two landscapes are based on the soil characteristics — poorly drained clay versus well drained sandy soils — and the agricultural land use they support, namely, cereal crops and

pasture versus tobacco and horticultural crops.

The Big Otter-Big Creek landscape has great potential for quality recreational development, but ecologically it is among the most delicate of the landscapes in the Study Area. Potential lies not only in the features contained as such but also in the fact that these natural corridors could be linked to the other landscapes as part of a larger regional system of the Study Area. This corridor system would include the Grand River valley and the Lake Erie shoreline, Long Point and the Big Otter-Big Creek landscape.

Priority should be given to establishing policies and guidelines to protect these valuable natural and, as yet, largely unspoiled resources from substandard, unplanned development by a small sector of the population to the exclusion of the general public.

Figure 12-11/The landscape south of the Norwich-Burgessville-Brantford line lying between the clay plain and the Big Creek valley comprises features of several landscapes in the Study Area.

Transitional Zone

The area south of the Norwich-Burgessville line between the clay plain and Big Creek valley is considered a distinct landscape personality, although it comprises features of several landscapes. The eastern part is similar to the clay plain landscape while the west is similar to the sand plain landscape; the northern part resembles the Brantford-Norwich-Burgessville landscape and the area in the south is similar to the Lake Erie shoreline landscape. It is considered therefore to be a rather complex transitional zone from the surrounding landscapes.

Natural Features. Many of the natural features which occur in the surrounding landscapes are obvious in this area, although most are of lesser significance and of lower quality.

Soil types, vegetation, rivers and streams are of mixed variety, each being found to some degree in other landscapes of the Study Area.

Manmade Features. These, too, resemble those of surrounding areas to give this landscape a distinct mixture of agricultural land uses, architectural styles and development patterns.

Summary. This transitional landscape provides a great variety of both natural and manmade features, none of which is unique to this area but all of which in combination provide an area of minor interest and recreational potential. Because of its diverse nature, development policies and plans for this area will likely be the most difficult to formulate.

Long Point

While an integral part of the Lake Erie shoreline landscape, this spit is so distinct a physiographic-ecological feature as to warrant classification as a separate landscape personality. This is based upon several factors some of which have already been described in Chapter 2, Geology and Geomorphology, and in the description of flora in this chapter. These factors are

1) The interesting combination of Lake Erie water currents, shoreline erosion and sand deposition which have given rise to this landform.

2) The unique flora and animal life — the former characterized by species of the Carolinian zone found only in that part of Canada, while the latter is said to contain an extraordinarily large number of snake species. While not unique, many deer reside in this area and the marshes produce large numbers of waterfowl.

3) A combination in close proximity of very distinctive landscape features — sand beaches and sand dunes, deciduous forests and marshes.

4) Spectacular visual quality of the above-mentioned features, made all the more interesting not only for contrasts among themselves, but also in contrast to the isolated setting in a large body of water making the spit unique at the provincial and national level.

5) The instability of the dune land ecosystem and its vulnerability to human destruction all of which has emotional and educational overtones in terms of interest of people in their environment.

In perceptual terms Long Point must be personally experienced in order to be fully appreciated. The marshes present serenity at its best; the sand beaches with a backdrop of dunes and a large population of gulls are a dramatic contrast to the water body; deciduous forests are found on prominent parallel sand ridges between which marshes and sedge lowlands are located; the white pine-juniper veg

gure 12-12/The Long Point spit is a distinctive and spectacular landscape because of its ıysiographic and ecological features. It should receive high priority for preservation.

tion stands out in strong contrast to e large rolling dunes of bright sand. lmost all of the Point is privately vned by the Long Point Company, a nall group of conservation-minded dividuals. Through their efforts and vestment this land has been preserved its natural state. Only a handful of ɔttages are located on it. At the present ne record-high water levels have ɔvered the continuous sand beach ıd eroded the dunes badly on the west de of the spit.

The vulnerability of this landscape human destruction combined with its ɔectacular physiographic, floral, ildlife and visual qualities suggest no her use than that of preservation as ı entirely natural area for public ıe under the most rigid controls. This ɔuld exclude all forms of active creation and all forms of passive creation except those related nature appreciation and interpreta-ɔn and for purposes of systematic ientific study. This area appears to eet the criteria for a National Land-ark currently under consideration by e National and Historic Parks Branch the Department of Indian Affairs and Northern Development. This category applies to areas which are small, scenic, spectacular and which should not be developed.

In view of the above observations the Land Capability Analysis of the Department of Treasury and Economics (June 2, 1970) should be noted; this analysis classifies Long Point and Turkey Point as being physically capable of carrying intensive recreation in Classes 1 to 3. The importance of suitability, as well as capability, is noted in the department's report but in the case of these two land areas this aspect needs to be strongly emphasized. Long Point may indeed, in the short-range, be capable of supporting intensive recreation but destruction of vegetative cover through intensive use may cause severe shifting of the dunes. As it is characterized by biological uniqueness of great instability and high visual value dependent upon low-intensity use, the criterion of suitability should be weighed carefully in determining its highest and best use. Further, the large marshes of both these land areas would not support intensive recreation.

Conclusion.
Rational development of each of the seven landscape personalities can result in a variety of experiences of national, provincial and regional significance. They should be linked through planned development to form a regional landscape corridor system which should become the most important feature of the future regional physical structure.

Recreational Facilities
Existing recreational facilities indicate that recreation has not been developed to anywhere near its potential. Additionally, there seems to be considerable evidence to suggest that the rate of increase in recreational activity, especially along the lakeshore, is not as rapid as it could be. This may be due mainly to
1) increase in water pollution,
2) limited access to recreation resources due to existing road pattern, and,
3) increase in access to and development of the northern lakes area of Muskoka, Haliburton and those beyond.

Although a decline in recreation activity seems apparent in certain places, there are sufficient environmental resources for it to expand. The Study Area abounds in numerous recreation resources, some of which are unique to southern Ontario and even to Canada. Indeed, the areas of the Big and Otter Creeks, and their tributaries, and the shorelands between Port Burwell and Port Dover represent, unquestionably, the finest scenery along the Lake Erie shoreline. The rapid expansion of the Niagara-Hamilton-Toronto urban corridor and other urban centers near the Study Area provide a large local tourist market. There is considerable American tourist traffic using Highway 3 as a short cut from Detroit to Buffalo, and as a route to other recreational areas in Ontario. With easier access and development of the natural and manmade resources, much of this tourist traffic could become captive to the Study Area.

When found in sufficient concentration the existing recreation facilities form nodes which are normally found in

the areas of highest scenic value and are usually reinforced by undeveloped natural resources.

Following are some of the major recreational nodes and developments identified in the Study Area:

1) *Port Burwell.* Sand beaches, cottages, fishing harbor, boat launching ramp, trailer camp, fishing and marina facilities are located in the village, in Iroquois Provincial Park and the Conservation Authority Area.

2) *Long Point.* Extensive beaches of high quality, camp grounds, picnic areas, cottages, tourist accommodations, marinas, hunting, fishing, golf courses, entertainment and restaurant facilities are found in Long Point Provincial Park and surrounding area. The recreational development is contiguous to unique scenic resources of regional and national significance. (See further discussion below.)

3) *Turkey Point.* An excellent beach, the historic site of Fort Norfolk, campgrounds, picnic areas, cottages, marinas, and a golf course are found here; hunting is permitted in the Turkey Point Provincial Forest but the marshes are privately owned. (See further discussion below.)

4) *Port Dover.* The amusement park, beaches and commercial and sport fishing activities in conjunction with Silver Lake and the museum afford a variety of facilities for active recreation. There are large marinas and numerous boat works of considerable public interest.

5) *Haldimand County Park.* The reception kiosk is perhaps the only well designed park structure in the entire Study Area but trailer camping facilities are devoid of trees and fireplaces. The plastic film-lined pool is used by up to 300 children per day.

6) *Peacock Point.* This choice recreation site is occupied by dense private cottage development. Because of its long shoreline as compared to its land area it would be put to better use in public ownership. Virtually no access to the shoreline exists and the beach facilities are in bad repair. Renewal studies should be considered.

7) *Woodlawn Park.* This is a private development near the mouth of Sandusk Creek which is wide at this point and with land quality capable of accommodating more facilities. Marina, beach, camping, and cottages on one side occupying the prime site.

Figure 12-13/The private sector has not been subject to developmental control in respect to recreational facilities, nor has it established a high standard. This is a littered area among exceedingly low standard cottages at Port Burwell.

8) *Selkirk Provincial Park.* An extensive, newly planted trailer camping area. Long shoreline of marsh along Sandusk Creek which is wide at this point. There is a small boat launching area at the mouth of the creek.

9) *Recreation Subdivisions.* Extensive cottage subdivisions line the shore between Selkirk and Dunnville; several appear to be of good quality. Private parks offer camping, trailer and picnic facilities. Foul sewage-like odors emanate from lake in dense cottage developments east of Selkirk.

10) *Dunville, Byng Island and Port Maitland.* Tourist accommodation, campgrounds, beaches, indoor recreational facilities, picnic areas, wildlife viewing, playing fields and boating facilities are provided by the town of Dunnville, Byng Island Conservation Area and Rock Point Provincial Park.

11) *Simcoe.* The town has tourist accommodation and restaurant facilities. The downtown park is an outstanding recreational amenity for local peopl and tourists alike.

12) *Waterford Quarries.* The Waterford Conservation Area affords quality camp sites, swimming, picnicking, fishing and boating facilities.

13) *Backus Conservation Area.* Nature trails, agricultural museum, mill, hunting grounds, bird watching and historic sites are located in this area north of Port Rowan.

14) *Paris, Brantford and St. George.* Numerous historic sites, museums, picnic parks, campsites, horticultural displays, canoeing facilities, picnic areas, beaches, fairgrounds and cultural activities are well represented in this recreationally well endowed area.

Numerous isolated recreational facilities are located throughout the Study Area. These are catalogued in the "Resources Inventory" in Appendix D.

The existing recreational facilities are classified as natural resources and manmade resources according to the following classification:[10]

Natural Resources	*Manmade Resources*
Water	Water
Wetland	Topography and geology
Topography and geology	Vegetation
Vegetation	History and culture
Wildlife	

The natural and manmade resources listed above are the basis of analysis to identify the recreational potential and related amenities of the Study Area. Further analysis of these resources is dealt with in this chapter under "Environmental Corridors".

Recreational facilities have also been classified as to ownership — *i.e.,* public and private. The following is a partial list of existing government recreational developments in the Study Area:

) *National Parks*
No national parks exist in the Study Area.

) *Provincial Parks*

oquois	— Port Burwell
ong Point	— Long Point
urkey Point	— Turkey Point
elkirk	— near Peacock Point
ock Point	— near Port Maitland
ames N. Allan	— Low Point

) *Conservation Areas*

unnville	— Dunnville
yng Island	— Byng
aquanyah	— near Cayuga
neida	— near Caedonia
ictoria Mills	— Victoria Mills
aterford	— Waterford
anessa	— Vanessa
eeterville	— Teeterville
utton	— Simcoe
uance	— Delhi
owan Mills	— South of Courtland
bigail Becker	— near Walsingham
ackus	— near Vittoria
orfolk	— near Port Ryerse
lack Creek	— near Port Dover
ay Creek	— near Port Ryerse
eer Creek	— near Langton

Private recreation areas are listed in e "Resources Inventory" of ppendix D.

The quality of the various recreational facilities varies considerably; some of the reasons are listed below.

1) *Public parks policy*
The geographical nature of the Lake Erie shorelands is such that prime recreational areas occur as very narrow strips without extensive interesting hinterlands and or as very small nodes such as at Turkey Point and Long Point. Public policy at the provincial level has not assisted in overcoming this natural disadvantage in the following respects:
a) Cottage sites, even in comparatively recent years, have been sold to the private sector thus reducing availability of prime recreation lands to the general public.
b) There is little evidence that the stepped-up shoreline acquisition policy announced in the Speech from the Throne on November 27, 1962, has been implemented. Only several small sites have been purchased since that time.
c) There are no long-range master plans for the shoreline as a whole or for existing or proposed parks and park sites.
d) Too much has been expected of the private sector in respect to providing a comprehensive range of recreational experiences and services of high quality in an area badly in need of both these factors. Without improved fiscal resources, a greater understanding of the needs of an increasingly sophisticated public, and a concerted and coordinated program on the part of the private sector, the future demands for recreation will not be met. Government must fill this void on a crash program basis recognizing precedents established in other parts of North America.[11]

2) *Site planning*
In public developments, conflicting land uses such as dense cottage development close to prime beach areas, as at Long Point and Turkey Point, inhibit maximum use of the beaches and detract from the quality of recreational experience of the general public. Straight-line alignments of roads encouraging speeding. Cottage areas are located close to main park roads without benefit of buffer strips.

3) *Design*
Design standards in both the public and private sectors are exceedingly low compared to those in other parts of Canada. At worst they are manifested in architecture of utility frame construction deteriorated to slum quality and at best they are crude contemporary versions of a design characterizing the long-since-passed romantic era. The same is true of parking areas, roads, docking facilities, signage, etc.

4) *Maintenance*
Low maintenance and lack of supervision has contributed to the poor quality of facilities. Lack of funds was cited as a problem.

5) *Plantings*
Otherwise satisfactory new recreational establishments suffer from lack of amenity such as new plantings of sufficient size to be useful.

6) *Pollution*
Frequent water pollution, even when below levels considered unsafe, such as in the Grand River and Lake Erie, deters people from engaging in water-oriented activities or mars recreational experience. Algae, turbidity and fear of toxic pesticide levels in fish are among these factors. The recent increased water level in Lake Erie has created numerous problems in recreational use and waste disposal.

7) *Over-use*
This is not a prevalent problem in the Study Area, exceptions being such major developments as the Long Point and Turkey Point Provincial Parks. Associated with over-use is that of mis-use in the case of physically or ecologically fragile environments; a notable example is the erosion through uncontrolled use of the natural phenomenon of the Houghton Sand Hills on Lake Erie.

8) *Cottage Development*
As water is the prime natural attraction for vacationers cottagers have been attracted to the Lake Erie shoreline. The location, density and quality of cottage development and the solution of this problem is described well by Dr. J. N. Jackson. He says, in part:

"Cottages in Wainfleet Township and Haldimand County are in general of average quality, with pockets of poor cottages in the vicinity of Port Maitland, Moulton Township, and especially at Miller Point where an untidy jumble of buildings on minute lots defies one to decide which is a cottage, which is an outhouse, and which is a tool shed. . . . There are pockets of better quality cottages west of Port Colborne, Low Point, and west of Nanticoke Creek.[12]"

While the quality of the cottage developments leaves much to be desired and thus detracts from the enjoyment of the lakeshore landscape, the problems that they pose in terms of prohibiting access is a monumental one which will require intensive study and decisive, early action by local and provincial governments. This is especially so with the prospect of the highly increased population growth which will accompany industrial development already actively under way. Dr. Jackson has also identified problems of access related to cottage development.

9) *Access*
Access to Lake Erie is limited by factors other than cottages. Lands between the shore road rights-of-way and the shoreline are privately owned thus involving trespassing to use shorelands. Also, the roads are located so that the lake cannot be seen. Travelers, therefore, are not aware of its presence and do not stop to enjoy it. Major river valleys such as those of the Big Creek and Big Otter, their tributaries and the Grand River also pose problems of access due to private ownership. The lands held in ownership by the conservation authorities are but the smallest fraction of that required to meet recreational needs of the near future.

Provincial Parks
While it is not within the terms of reference of this study to make detailed site analyses it was considered important to do so with several established provincial parks in order to analyze serious problems which were identified in these developments and to suggest long-range prototype solutions. Certainly the expected population growth in the Study Area warrants such an analysis. The Turkey Point and Long Point Provincial Parks have been selected for analysis for the aforementioned reasons.

To understand the problems of provincial parks at the general level, several points should be noted. First, it is the responsibility of the Long Range Planning Section of the Parks Branch of the Department of Lands and Forests to develop long-range plans for both regional systems and individual sites. Once these plans have been developed, it becomes the responsibility of the regional park supervisor to implement and manage them. Park superintendents have on-site responsibility.

Another factor to be considered is that the province owns a "fisheries reserve" of 132 feet back from the entire water line. Numerous problems arise from this situation as will be noted below.

Turkey Point Provincial Park
At the Turkey Point Provincial Park the single most important problem to the visiting user public is private ownership of cottages and commercial enterprises within the park boundary. This ownership consists of prime land contiguous to the heavily used public area. As a result badly needed facilities such as roads, parking, boat launches and picnic areas cannot be expanded. Major traffic jams requiring two hours to enter and leave the park at peak times are common. Cottage residents continuously object to basic facilities being located on the beach for public use.

The second serious problem is incompatibility between the cottager and the park user. The cottager situated on land contiguous to the fishery reserve (beach area) treats it as his own. Some take it over completely while others erect psychological barriers to deter the park visitor from using the park area in front of the cottage. Also, cottagers expect the Parks Branch to fill in nearby scenic marsh areas for purposes of insect control.

Commercial enterprises, being

Figure 12-14/Incompatible land uses and poor site design characterize the provincial Parks. This photograph at the Turkey Point park shows these problems where beach activities, parking facilities, cottages and high volume traffic arteries destroy the quality of recreational experience.

Figure 12-15/This fisheries reserve strip consisting of prime beach at Long Point poses acute problems of user compatibility and jurisdictional responsibility for maintenance.

ocated on land under the jurisdiction of he township, are not subject to stringent controls on architecture, parking equirements and billboards. The result s one of esthetic absurdity. The ques- ion of locating marinas in a prime ublic area such as this would seem to eed review.

Sewage disposal is a major prob- em with reports that lack of control by he Township of Charlotteville has esulted in sewage running in open litches.

About 100 of the 800 cottages are interized for year-round residence. Vhile cottages vary markedly in quality, ermanent brick residences have been onstructed accentuating the long- ange use considerations of this aluable park land.

There are pressures to build cot- age subdivisions and there is already vidence of major dredging operations the marsh lands to create building tes.

A previous proposal by the Parks tegration Board for acquisition of ome cottages was thwarted by cot- gers, illustrating the high degree of olitical control exerted by a small number of people.

Approximately 5000 acres of marshland is owned by five hunting clubs, few members of which are Ontario residents. Canals have been dredged to provide direct access to hunting ponds. Otherwise the marshes are well managed for wildfowl production. This 5000 acres consists of a narrow strip of land on the lake side which contains an apparently virgin stand of timber and a rich flora of outstanding scenic beauty.

Despite the abundance of rare flora, large numbers of visitors, and the desire of park officials for a nature interpretation program, no such program is yet in effect. Without such a program this particular park cannot be considered fully developed for public benefit.

Long Point Provincial Park

A variation of the conditions outlined above exists at the Long Point Provincial Park where there is approximately 5 miles of prime sand beach, only one and one-half miles of which is in the Park. Again, cottage lots on the finest of potential park land have been sold to the public, even in comparatively recent years, demonstrating the absence of long-range planning. Because the cottages are located contiguous to the fishery reserve frontage, residents feel they have special beach privileges and resent the use of this land by the general public. As this land is under the jurisdiction of the Public Lands Act, rather than the Provincial Parks Act, park officials are confronted with a very frustrating situation; it is heavily used by the public but no parking, garbage and washroom facilities and no clean-up or surveillance services are available. These are strongly demanded by the cottage residents, and even by travelers from Highway 59. The problem is currently unsolved for both the Township of South Walsingham and the Parks Branch disclaim responsibility and no services are provided by other sectors of the public. In view of this problem and that of turning away visitors three or four days a week during the summer season, there is need for a detailed study to determine the disposition of private ownership and extending public ownership and services.

In both parks the style and quality of cottage architecture and landscape

treatment varies and is not at all consistent with the idea of natural surroundings.

The presence of large and excellent beaches on Long Point draws an active-recreation-oriented public who use the water for boating, swimming, water-skiing, fishing; also, these people are interested in amusement. At Turkey Point, on the other hand, part of the attraction is the quiet forest surroundings offered for trailer camping.

The Long Point Waterfowl Management Unit of 1800 acres of marshland was created recently under the Public Lands Act. Located on the Inner Bay it is to be managed for wildlife reproduction and hunting.

Figure 12-16/An open channel through the marsh in Inner Long Point Bay near Port Rowan. The flora of this area contributes to the unique quality of this landscape.

The foregoing analysis suggests that the Province of Ontario should undertake immediately a stepped-up program of comprehensive long-range park planning encompassing the entire Lake Erie shoreline and individual sites, both existing and proposed. *This is especially important as no such program exists or is envisaged.* These planning efforts should complement plans and activities of regional and local agencies. A detailed study should be undertaken to consolidate park ownership and to study the ramifications of private ownership in provincial parks of outstanding recreational value. If pre-emption is found to be warranted, alternatives such as the following should be considered:

1) Purchase through expropriation.
2) Purchase as real estate is placed on the market.
3) Relocation of structures on planned recreation subdivisions outside of the parks.

Boating on the Grand River

Recreational boating on the Grand River represents a potential so great in the future of Haldimand-Norfolk as to present a challenge to the vision of the people of Ontario. The natural and cultural environs of the river have already been described above and it is evident that they provide precisely the kind of setting to attract, complement and satisfy a boating public.

Dr. Peter Klopchic of the Ontario Department of Tourism and Information conducted a feasibility study in 1968 of recreational boating on the Grand River. His analysis showed no doubt that not only will there be a signficant demand for boating on the river but that investment in such a program would bring distinct economic benefits.[13] It was found that boaters docking at the new Ontario government dock at Dunnville expressed a desire to go upriver. Two hundred boats used the river between Dunnville and Cayuga and 700 between Caledonia and Newport just below Brantford, despite segmentation of the river by insufficient dams and lockage.

It was estimated that 5 new dams and locks required to open the river from Port Maitland to Newport would attract a potential of 5000 Canadian and U.S. tourist-boaters within a few years after completion. A $10,000,000 investment in the canal by the three levels of government could bring a tax revenue of $630,000. With growth of wealth in the Study Area, an increasing number of households may be expected to use boats. This revenue figure, therefore, could be expected to increase significantly. This study of the Department of Tourism and Information should now be reappraised in light of the industrial developments in Haldimand-Norfolk and in light of recommendations made below for a Grand River Parkway.

Unique Natural Landscapes

Natural landscapes having outstanding characteristics have been identified in various sections above. It is incumbent upon society to preserve these unique and strategic ecological associations in southern Ontario, and in the Haldimand-Norfolk Study Area in particular for the following reasons.

1) Some rare plant species are believed to have become extinct in Ontario as a result of man's activities during this present century, and others are in definite danger of complete destruction (e.g., some 19 different kinds of bog orchids which are known to exist in Norfolk County). Scientists, naturalists, and informed citizens all agree that we have no right to destroy entire species of organisms.
2) All plant associations have a role to play in the protection of the entire habitat of which they are a part. Plant

cover protects soil and sand from erosion by wind and water. Plants provides the food, cover, and nesting sites for animal species. And finally, green plants alone are capable of carrying on the continuous cleansing process of the earth's atmosphere, as they convert carbon dioxide gas to foodstuffs, at the same time as they release oxygen gas for animal respiration.

3) Specific habitats (namely, the deciduous forests, the sand hills and sand dunes, and marshes) which have been cited within the Haldimand-Norfolk Study Area are of great scientific value because of the varied admixtures of species which they contain. Carolinian species in southern Ontario are reaching the extreme northern limits of their ranges. Mixed with these southern species in a number of the associations which have been cited, we find northern plants, such as bunchberry, goldthread, and twinflower, which come to the extreme southern limit of their range in some of the cold wet habitats of Haldimand and Norfolk. Botanists, ecologists, and all naturalists agree that these associations should be preserved for continuing present study and for future generations.

4) A protective buffer zone is of great importance around any specific area which is to be preserved. The reasons for such a buffer zone are many. In addition to the physical protection afforded by the transitional buffer zone against marauding human beings or domestic animals, an essential ecological and biotic role is played by this peripheral zone as it serves as a watershed, or protects against dessicating winds, or results in a heavier and longer-lasting snow cover for the more central area.

5) The lake marshes of the Haldimand-Norfolk Study Area are particularly important to migrating water birds. Much of the North American continent is included in the range of some of the species of ducks, geese, grebes, and swans which depend upon these lake marshes for food and cover, at least during their periods of annual migration, not throughout their nesting period.

6) From a purely monetary point of view it seems wise that the land for strategic

Figure 12-17/Restored period architecture of this type is an example of the large number of heritage resources in the Study Area.

ecological preserves in the Haldimand-Norfolk area be set aside at the earliest possible date. Land values are now high throughout southern Ontario, but there appears to be no indication that they will become lower at any future date.

7) Finally, uniqueness — in which the importance of regional contrast is implicit — is an edifying recreational and educational experience sought by an increasingly understanding and educated public. Growing demand for this kind of experience by a more sophisticated recreation-seeking public has been identified and recognized in recent Government of Ontario studies.

Cultural Resources

Regional interest, character and personality are derived from both *natural* and *cultural* resources. The manmade resources referred to in this section under "Recreational Facilities" and "Environmental Corridors" are composed largely of what may be termed cultural resources. These include historical heritage, ethnic patterns, architecture, agriculture, fishing, archaeology and so on. The Haldimand-Norfolk region derives much of its character and personality from cultural resources but, like the recreational resources, little advantage has been taken to date of these unique features; they should be articulated to strengthen *genius loci* and intra-regional personalities and contrast.

As with recreational facilities, cultural resources, when found in sufficient concentration may form nodes and corridors. The two main cultural corridors identified in the Study Area are[14]

1) *Grand River valley.*

The historical heritage of this waterway gives expression to the most visible of the cultural corridors in the Study Area. Agriculture, architecture and ethnic patterns are readily evident although some of these features are becoming lost in the matrix of urbanization, transportation and what is otherwise known as "progress". Paris, Brantford, the Tuscarora Indian Reserve, Dunnville and Port Maitland are important cultural nodes within the Grand River valley corridor. The cultural resources are strongly reinforced by the natural

Figure 12-18/Buildings of architectural and historic merit, such as this terminal at Paris, should be considered a heritage resource rather than be eradicated by demolition.

resources of this landscape.

2) *The Lake Erie shoreline.*

The historical heritage of the lakeshore is not so obvious as that of the Grand River valley and the potential is still dormant here. Architecture, ethnic patterns, agriculture and fishing are cultural resources within this corridor. Nodes of resources are found at Port Maitland, Port Ryerse, Turkey Point, Long Point. Normandale, Port Dover, Port Rowan and Port Burwell. Again, the cultural resource is reinforced by the natural and manmade resources of the landscape.

A number of isolated areas of cultural resources have been identified in the Study Area in the Landscape Inventory section. The ethnic patterns and agriculture of the town of Delhi give evidence of a significant cultural character, composed of fairly recent European immigrations. The ethnic and religious pattern reinforced by agriculture and rural architecture are identifiable resources of the 2 Mennonite settlements in the Study Area. The historical heritage and architecture of Simcoe, Paris, Vittoria and Vienna provide distinctive personalities for these towns and villages.

Perhaps the greatest single potential for use of cultural resources in the Study Area is in Vittoria. Through restoration, preservation and landscape improvement of the village and with addition of other examples of 19th century Norfolk County architecture from the surrounding countryside, it could be developed into a historical village similar in concept to that of Williamsburg, Virginia.

In almost every instance, the cultural landscapes described above are reinforced by significant natural landscapes, so that most of the cultural resources are found within environmental corridors. Thus, the potential for a diverse and important recreational base exists in the distinct landscape patterns of the Study Area.

Ethnic Groups

Greater cultural awareness today gives a new dimension to regional interest through the existence and activities of ethnic groups. The culture of the Six Nations Confederacy of the Tuscarora Indian Reserve, which presents the most potential, is beginning to be developed through the annual festival and development and exhibition of handicrafts. As the Study Area does not possess a really unique historical/ethnic heritage the Indian culture could fill this void to create a feature of primary regional significance.

Apart from the Indian culture, descendants of the United Empire Loyalists have the longest link with the early history of this part of Canada. They are not a group of single ethnic origin, however, and they do not possess cultural traditions, their early architecture being their strongest expression. Ethnically they are a mixed group of British, German and other origins and, as these people were busy building their farms, the Loyalist "myth" did not develop until after the War of 1812 when imperialism was in fashion. While there is a Loyalist history, the UEL influence has disappeared and its significance is manifested in searching out and taking pride in descendancy from the original group. In individual instances, interests are expressed in the placement of plaques such at at Simcoe, and by individuals of UEL origins who actively supported the development of the Eva Brook Donly Museum of Art and Antiques in Simcoe.

While statistics show significant numbers of non-British European groups and several large and well operated ethnic clubs, their presence is not greatly felt at the regional level. Belgian, Polish, Hungarian and German clubs are found in Delhi some of which are open to the general public. Modern entertainment is featured while ethnic entertainment is provided for their own members. Their halls are open to the public also for social and fundraising events and for public meetings. There are no national festivals such as the Oktoberfest at Kitchener but there is an annual Belgian sports day at Langton in June which features pigeon and bicycle races, archery, and song and dance events. Also, the ethnic presence appears publicly occassionally in, for example, the well-accepted contributions to annual parades at Port Dover and Delhi.

Table 12-1/Populations by Ethnic Groups for Counties and Census Division, 1961.

Ethnic Group	Brant	Haldimand	Norfolk
British Isles	56,498	17,687	27,992
French	2,525	683	1,283
Austrian	298	101	307
Czech and Slovak	263	93	466
Finnish	77	37	22
German	4,189	4,456	4,405
Hungarian	2,476	249	2,789
Italian	1,612	352	173
Jewish	154	7	28
Netherlands	2,934	2,072	2,998
Polish	2,818	238	1,268
Russian	197	37	153
Scandinavian	506	192	223
Ukrainian	1,620	322	1,556
Other European	1,447	250	6,067
Chinese	47	30	51
Japanese	25	—	15
Other Asiatic	220	38	7
Native Indian and Eskimo	4,142	979	288
Negro	99	8	18
Other and not stated	1,692	366	366
Total	83,839	28,197	50,475

At Simcoe the European Canadian Social Club stages a festival on the annual Civic Holiday. In general, the passing of the first generation and the scattered population distribution mitigates against staging national festivals. Nevertheless, these groups might well be encouraged to investigate the possibility of a greater contribution to the regional scene.

Highways, Roads and Pleasure Routes

The absence of a comprehensive transportation plan in the past is easily discernible through the multiple and opposing functions of a number of highways and roads. As a result, the full potential of character and esthetic appeal of many of the transportation routes has not been realized and cannot now be. The pattern of highways and roads which does exist has an identifiable hierarchical structure but with several significant gaps.

There is no limited access through highway in the Study Area. Highway 3 is the major east-west route, with Highways 6 and 24 serving as the major north-south routes. Highways 54, 59 and 19 serve as secondary north-south routes. Many county roads, both paved and gravel-surfaced, interlace the area and township roads, mainly gravel-surfaced, complete the typical southern Ontario grid pattern oriented from the Lake Erie shoreline.

As transportation corridors, the highways and roads provide access to various facilities and residents. While these roads provide access to urban centers, and to agricultural production areas and markets within and outside the Study Area, they do not provide access to recreational resources and features within it. As emphasized in other sections of this report, the Lake Erie beaches, the wooded valleys of the Big Otter and Big Creeks, and the Grand River valley are virtually inaccessible by road. This is fortunate in certain respects as it has deterred undesirable kinds of development in many potentially useful areas. It is unfortunate, however, in that quality development has been prevented and continues to be prevented through the lack of access. Not only are recreation-seekers physically unable to reach natural recreational resources, but there is also lack of opportunity for visual contact with these scenic resources. The lakeshore, with extremely limited visual access to its shores, beaches, cliffs and woodlands, is an excellent example.

No designated scenic highways, roads or parkways are located in the Study Area, although the potential is high and the need obvious. There are large numbers of abandoned and dead-end roads, many ending at water and wetland features.

Highway 3

The numerous functions of Highway 3, the main east-west route, impart to it a confusing and conflicting character. It is the major transportation link between Windsor-Detroit and Buffalo, carrying a large volume of American tourist traffic between these points. The variety of traffic it carries also includes trucks from the Cayuga gravel pits, peak loads from the Cayuga Raceway, farm tractors and equipment, and local traffic between urban centers. Further, it becomes the main street of the towns and villages which it bisects, including Tillsonburg, Courtland, Delhi, Simcoe, Renton, Jarvis, Nelles Corner, Cayuga, Canfield and Dunnville. The rural frontages along this highway are usually of little interest; the topography is flat, trees have been removed in road widening and ditching operations, and little direction is given to rest areas, picnic sites and other recreational features. There is an apparent need for a through route to replace Highway 3. The same mistakes of too many functions for one highway, disruption of small towns and villages, destruction of the landscape elements such as trees, and lack of access to rest areas should obviously be avoided.

Rural Roads and Highways

A few sections of rural roadways and highways are especially significant because of their arcades of large oak and maple trees. Especially around Brantford, Burgessville and Norwich and in several other areas, these arcaded roads bring relief from monotonous stretches of open plain. It is highly desirable that inexpensive tree-planting

Figure 12-19/Road "improvement" in the Study Area is characterized by a singular approach with emphasis on the road surface only. Beautiful tree-arcaded roads typical of the southern Ontario landscape are disappearing through this narrow approach to road improvement.

programs be undertaken in both urban and rural areas to recreate much of this type of street and highway landscape which has been lost through road widening, ditching and neglect. A comprehensive policy should be adopted to realize the inherent potentials of such a program.

There is great potential and need for rest areas, pull-offs, and picnic spots in the entire Study Area. Facilities at numerous stream crossings, reforested areas and woodlots adjacent to existing highways and roads would be of significant benefit to weary travelers and pleasure-driving motorists. There is particular opportunity for this kind of development along the lakeshore and river valleys of Norfolk County and the Grand River valley. Because pleasure driving is the most popular present-day recreational activity, it is important to preserve country roads for future recreational driving, as well as for transportation needs.

Streets

Because of its diverse function, Highway 3 and other main highways have degraded town and village main streets. The character of many streets has been obliterated or is in grave danger of being so, through successive widenings. Pedestrian needs have suffered correspondingly. Examples of destructive transportational influences are especially evident in Simcoe. Highway 24 will ultimately have seriously deleterious effects on Simcoe's central business district unless a bypass is planned soon.

Strip Developments

Compounding the problems associated with search for identity in urban centers is the typical North American strip development — the result of non-planning. Where building development does not occur along the major highway routes, signs, billboards and other items of visual pollution take their place. The contrast between the entrances to Vittoria and Port Dover illustrates the difference between this urban identity and non-identity. The entrances to Vittoria are uncluttered and devoid of strip development, probably because the village, being small, has less commercial activity. Here the motorist experiences a sense of arrival at the square and a feeling of place and of identity. On the other hand, the approach to Port Dover is characterized by residential development and numerous billboards. Port Dover's problem is further aggravated by the absence of a focus for the town. Consideration should be given to making the amusement park a strong complementary focal point along the lakeshore. Even towns with a focus, however, have trouble; uncontrolled strip development along Highway 3 in Simcoe is diverting development from the downtown area. A strong policy should be developed to restrict strip development and enhance the natural qualities of the entrance to the many towns and villages of the Study Area.

Scenic Amenity

Recreational roads have not been designated within the Study Area even though there are a number of routes which provide rich recreational experiences. The quality of these routes is completely dependent upon the countryside which they traverse. No attempt has been made to recognize the natural scenic resources through right-of-way design or route selection. The routes of highest recreational potential are elaborated upon further in this section.

Contrast in the quality of scenic amenity as related to road development is illustrated in the old and new valley crossings, especially in the deep, wooded valleys of the sand plain. The old roads cling to the side of the ravine and cross the stream on steel-truss or wooden bridges allowing the motorist to experience the sharp contrast of the flat, open agricultural landscape with the wooded, intimate landscape of the stream valley. The new roads are elevated to tree-top level and are either constructed through filling the valley or through use of concrete pier bridges. The early approach affords a change of pace, contrast, visual relief and takes advantage of the natural scenic resource. The recent approach, however, negates the aforementioned features and, at the same time, destroys much of the valley character through filling.

Some of the most dramatic views

of natural scenery are located on dead-end and abandoned roads which cross the Big Otter Creek and Big Creek valleys. The experiences afforded by these roads could be capitalized upon by opening these rights-of-way for hiking and equestrian trails. At the same time these abandoned rights-of-way could provide access to the natural recreational resources.

Vegetation along highways and roads is a vital aspect of the relationship between the highway and the landscape. Old patterns of vegetation have been eroded by new road construction, spraying programs and hedgerow removal. New policies must be adopted to protect and enhance the traditional visual integration and complementarity of highway and countryside. Roadside planting should be undertaken not only for the beautification of the roadside, but to meld the highway with the countryside and forming living green corridors through urban areas. This form of environmental design could accomplish the linking of rural and urban spaces.

Within this context rural roadside vegetation should consist of indigenous plants or those of a similar nature. The Carolinian flora of the Study Area should be used to preserve the unique vegetational character of southwestern Ontario and to give identity to the Study Area. Exotic materials and planting schemes can be used in urban areas where environmental requirements of vegetation are less hospitable.

Plant materials can be used in a variety of ways to provide relief from monotonous countrysides and distracting urban scenes. As part of the environment they would contribute to safety by alleviating monotonous driving and yet be part of the rural-natural scene.

Planting policies should be directed at screening junkyards and other undesirable scenes, breaking snow, screening headlamps from approaching traffic, and providing definition for highways through areas which lack topographical definition.

Railways

Railways follow the road pattern in many instances, and consist of the main east-west Michigan Central line and numerous north-south lines of the Canadian National, Canadian Pacific, and Toronto-Hamilton and Buffalo originating at various ports along the lakeshore. There exist a large number of abandoned railway rights-of-way which have significant unexplored potential for recreation purposes such as scenic easements and trails.

Figure 12-20/This abandoned railway right-of-way has potential as a recreational corridor for hiking and bridle trails and cycle paths, linking recreational facility nodes.

The two major railways, Canadian National and Canadian Pacific, have retained some of these abandoned rights-of-way, although their policy is to sell them where possible. As a matter of policy, Canadian National approaches provincial departments, such as Lands and Forests and Highways, for advice as to whether or not these Departments are interested in the purchase of the lands in question. If their reply is negative, public utilities corporations such as Bell Canada and Ontario Hydro are queried as to their requirements. If they in turn are not interested the local municipalities and finally the abutting land owners are approached.

Canadian Pacific appears to have a less generous policy of disposition of these lands, simply stating through their agents, Marathon Realty Company Limited, that abandoned rights-of-way are disposed of to the advantage of the public. Canadian Pacific should be approached by the Government of Ontario for cooperation similar to that provided by Canadian National.

The above policy illustrates that purchase or control of abandoned rights-of-way, some of which are found in the most scenic corridors of the Study Area, is a relatively simple procedure for provincial departments concerned with recreation but to date there is no evidence of purchase for recreational purposes by these departments. A firm policy should be established soon in this respect.

Parkways and Pleasure Routes

There is abundant potential for parkways and pleasure routes in the Study Area. Three distinct areas are particularly well suited for this purpose.

1) The forelands of the Lake Erie shore.
2) The Grand River valley.
3) The Big Creek valley.

The character of the lakeshore land, especially between Port Dover and

Figure 12-21/There is potential for a regional scenic parkway along the entire Lake Erie shore. This section of rural roadway between Port Dover and Long Point should receive high priority for development as a scenic drive.

Long Point, lends itself to the esthetic appreciation of the natural landscape; this is manifested in terms of land ownership patterns, land uses and road patterns which would facilitate the planning and construction of a parkway. Water, gorges, wooded banks, bluffs, variable topography, beaches, marshes and forest are located in abundance along this route. These natural landscape resources could be capitalized upon by the construction of a parkway using much of the existing alignment. This parkway would be the finest scenic drive along the entire Lake Erie shore, and also could provide access to the many recreational facilities and potentials of the lakeshore and its interesting environs.

Similarly, there is excellent potential for a parkway between Brantford and Port Maitland from which the Grand River and its valley may be enjoyed for its scenery and the historical, cultural and recreational facilities and potentials of this valley corridor. Such a route is consistent with recommendations for a recreational boating program made by Dr. Klopchic of the Department of Tourism and Information. It would need to be established as part of a comprehensively planned and designed greenbelt in which all the river-front towns could relate their own plans to a comprehensive plan for the valley. Similar recommendations have been made in the past but apparently not seriously considered. Early action is important as sections of the valley are already intensively developed.

An inland scenic drive of significant potential which is a fairly short but very scenic is the section of Highway 19 between Port Burwell and Vienna. Nowhere in the Study Area can the typical deep valley of the sand plain be appreciated from the road as in this section. The potential for a future scenic drive and its related resources is obvious. Such a project would entail scenic easements and other land use controls. The feasibility of a parkway up the Otter Creek valley as an extension of the Port Burwell-Vienna scenic drive should be investigated, even though existing land uses and topography pose distinct problems. However, the significance of such a project must be viewed in several contexts: a greatly expanded future population, a network of recreational routes of a region larger than the Study Area, and encroachments upon the valley which are sure to occur as pressures for country living develop.

In view of the growing shortage of open space precipitated by increased population and rising land costs, early consideration should be given to a comprehensive study of pleasure routes in southern Ontario. The various serious proposals made and studies conducted to date for separate routes should be reviewed in an integrated way. The first systematic study conducted in Ontario for a scenic drive was made on the Niagara Escarpment between Queenston and Hamilton. The study was undertaken by the Tri-County Committee of the Niagara Peninsula and carried out by Richard Strong Associates. Later a plan was developed by the Niagara Parks Commission for the Niagara River Scenic Drive from Fort Erie to Niagara-on-the-Lake; it includes the existing Niagara River Parkway. The Niagara Escarpment Study by Professor L. O. Gertler considered not only the Tri-County proposal but extended this idea to the entire length of the Escarpment. Dr. J. N. Jackson's study of the Lake Erie shore commissioned by the Niagara Regional Development Council proposed a "Rainham Parkway" based on a re-design of the Rainham Road between Dunnville and Port Dover; this proposal will be elaborated upon with a view to considering the desirability of a parkway along the entire Lake Erie shoreline which might connect with the Niagara Escarpment Scenic Drive at the Fonthill and Fort Erie points at the easternmost end. In the west it might connect with the already studied St. Clair Parkway which is part of the Blue Circle Drive between Sarnia and Detroit on both sides of the boundary.

As the above proposal would require immediate interim land use controls as well as permanent long-range controls, current techniques of control combined with new legislation would need to be explored. It is

Figure 12-22/This section of the Grand River valley west of Brantford is illustrative of a natural scenic landscape. Endowed with vegetation, water and interesting landform it is known as an environmental corridor.

suggested that consideration be given o the creation of a "Special Park District" to achieve these and other objectives.

Environmental Corridors

Landscapes frequently contain certain valuable natural and manmade resources which, when found in sufficient concentrations, may form recognizable patterns. They are frequently found in linear patterns as they are normally associated with water bodies and landforms comprising those resources which contribute to high environmental quality. These linear patterns of resources are termed environmental corridors and were identified as a result of a synthesis of the field observations listed in the inventory of the appendix. The environmental corridors should form the basis for conservation and development programs, especially those related to recreation (see Map 12-6).

The resources identified in the Study Area have been categorized according to the following:

Natural Resources
Water
Wetland
Topography-Geology
Vegetation
Wildlife

Manmade Resources
Water
Topography-Geology
Vegetation
History and Culture
Archaeology
Urban Quality

The following are the major environmental corridors of the Study Area:

1) *The Lake Erie shoreline.* The beaches, bluffs, woodlands, marshes and recreational facilities afford a large natural and manmade recreation resource base.

2) *The Grand River valley from Paris to Port Maitland.* The topographical relief, river, marshes, vegetation, historical and cultural resources and views illustrate the largely untapped reservoir of recreational development potential.

3) *Big Otter Creek valley and its tributaries.* These largely undeveloped valleys afford a unique opportunity in the Study Area to provide high quality recreational development and conservation oriented to forests, wildlife and water.

4) *Big Creek valley and its tributaries.* These valleys are of similar nature and significance to the Big Otter Creek valley.

5) *Sandusk Creek valley and its tributaries.* This valley is of less significance in relation to the Grand River, Big Otter Creek and Big Creek valleys, but with rehabilitation could provide a much needed recreational and amenity resource for the clay plain landscape.

Recreational Resource Nodes

From the graphic analysis a number of highly concentrated areas of resources were identified in nodal patterns. The following are nodes of recreational resource development and potential.

1) *Mohawk Point-Port Maitland-Stromness area.* A large concentration of cottage development, commercial fishing, beach and bluff, woodland, topographical interest, recreational facilities and historical resources present an array of existing and potential recreation and amenity.

2) *Peacock Point.* The beaches, woodland, the nearby Selkirk Provincial Park and cottage development combine to form an environmental node.

3) *Port Dover.* This is the site of excellent sand beach, amusement park, active fishing port and fine old homes.

4) *Turkey Point marsh and Provincial Park.* The marshes with a backdrop of wooded bluffs are the habitat of a large number of local and migrating wild birds. This resource combined with the provincial park and fine beach provides excellent opportunity for public recreation.

5) *Long Point marshes, dunes and Provincial Park.* The unique ecology of the dunes, marshes, vegetation and wildlife is the most delicate natural resource in the Study Area.

6) *Town of Paris.* Situated in the Grand River valley, this town's history, architecture and physical pattern makes

it the most picturesque urban center within the Study Area.
7) *City of Brantford.* Similarly situated in the Grand River valley. Brantford's history and culture, oriented to the Mohawk Indians provides it with outstanding potential for recreation.
8) *Town of Dunnville and village of Byng.* Although also situated in the Grand River valley, the character of these urban centers is quite different from that of Paris or Brantford. The river is wide and marshy; nearby are the Byng Conservation Area and numerous historical resources.
9) *Port Burwell.* Situated at the mouth of Big Otter Creek. Excellent opportunities for visual and recreational amenity have been largely negated by misuse of the natural resources.
10) *Backus Woods and Conservation Area.* The woods, described in the section on Historical Ecology are one of the few large remnant forest stands in southern Ontario. The Backhouse mill and agricultural museum is situated nearby in a scenically attractive area on Dedrich Creek.

An important aspect of the environmental corridors listed above is that they are linked, each flowing into the other to form a potentially high-quality environmental system which should be recognized in the formulation of development policies and plans for the Haldimand-Norfolk region. The major corridors are enhanced by numerous minor ones consisting of forests, swamps, topographical relief and streams. These minor corridors can also play an important role in the structuring of an open space system as it relates to entire ultimate land use in the Study Area.

Urban Quality

Although most Canadians live in urban areas, much of the population in the Study Area is rural. Many urban centers of the Haldimand-Norfolk region are small concentrations whose people are oriented to agriculture or fishing. Brantford and Paris are two major exceptions. Because major growth is expected in the region, the character and personality of all the villages and towns of the Study Area cannot be maintained. However, desirable existing urban qualities should be retained and articulated where possible. Where negative values exist in basically sound features, restoration must be undertaken. The recognition of the positive values — those which lend character and personality and which are of regional significance — should be the first step in the expansion of existing centers and the building of new cities. Through the reassertion of natural influences and imaginative design of city structures, new and old towns could create urban environments consistent with the highest aspirations of the people of the Haldimand-Norfolk region.

Figure 12-23/Tree-arcaded streets in residential areas are common to many towns and villages in the Study Area. They are an important aspect of quality in the urban landscape.

Positive Aspects

The following are some of the positive aspects of urban quality identified in the Study Area.
1) The picturesque and historical appearance of the small villages typified by Vienna and Vittoria should be preserved. Urban expansion and renewal could readily destroy the character of these villages. There is great potential for restoration and recreation through recognition of the natural and cultural amenities of these villages.
2) One of the best examples of urban quality in the Study Area is in the town of Simcoe. The downtown park system based on the Lynn River and the historic oak plain lends character to the city. Houses are well maintained and the streets are arcaded with trees; a sense of beauty, pride and dignity characterizes this town.
3) Locations of many of the towns and villages show recognition of natural influences. Paris, Delhi and Tillsonburg, located in deep stream valleys, are afforded a variety of natural elements which should be the focus in their urban structure. Conservation of these natural resources presents a unique opportunity in this respect.
4) Historical architecture is an important aspect of urban quality, especially as it contrasts with contemporary architecture. Paris is richly endowed with historical buildings which warrant preservation. Many other towns in the Study Area also contain buildings of historical merit.

Figure 12-24/The riverside park at Simcoe is a major aspect of the urban quality of that town. It is an example to be followed in existing and new towns of the Study Area.

Figure 12-25/Industry has traditionally located on water, leaving residents of cities such as Brantford and Paris with little access to a great scenic and recreational resource.

5) Another aspect of urban quality is public buildings and grounds such as the new city hall in Brantford, the parks of Simcoe, Delhi and Byng, and the public beach of Port Dover. They are important in establishing a high standard of development for the entire community.
6) The economic base of the lakeshore ports, that is, commercial fishing, is a characteristic unique in Ontario. Ports, docks, fleets of boats, and the activity of the catch exemplify the atmosphere associated with the fishing villages of Port Maitland, Port Dover, Port Rowan and Port Burwell.

Negative Aspects

There are negative values of urban quality which, unlike the positive values, are not peculiar to the region but typical of the North American urban scene.
1) Downtown areas in many towns are inundated with glaring and garish signs competing for attention. The amusement park at Port Dover with real potential for a highly sophisticated recreational development of the same type is dirty, shabby and garish. The main streets of Brantford are much in need of face-lifting renewal.
2) Brantford, Dunnville and Tillsonburg have turned their backs on their prime natural features which should be their foci — their rivers. This physiographic feature has been disregarded with industry having choked off the city from river banks, turned the public away and polluted the water.
3) Serious urban blight, however, is fairly unusual in the Study Area, being most apparent in Port Burwell. Deteriorated cottages, derelict fishing boats and fish huts, and trailer homes present a very negative aspect. The river, lake and the beaches are resources around which the economy of the town could be built.
4) While industry has brought economic prosperity to several urban centers, it has been accomplished at the cost of urban quality in some cases. Air, water, noise and visual pollution are apparent at Port Maitland. The Electric Reduction Company plant dwarfs the fishing village, polluting the air and water, killing vegetation and detracting from the natural water-associated sounds of gulls and waves.
5) Expansion of traffic arteries has been destructive of environmental quality in some towns and villages. For example, the tree-arcaded approaches to Scotland have been bulldozed in the process of road widening; a similar problem has been experienced in Simcoe. It is important that more sensitive planning and design solutions be found, particularly in respect to bypass routes.
6) Strip development is one of the most obvious of urban ills. Examples of this problem have been cited above in Simcoe, Port Dover and Waterford although others exist as well.

Potentials for urban quality of a high order are probably better in the Study Area than in any other part of Ontario. Because urban development has been limited, mistakes made to date have been relatively minor. With the advent of accelerated urban growth, special attention must be exercised at the outset to prevent the irrevocable mistakes which characterize most of the North American urban scene.

Extractive Industry

The mineral extraction industry of a rural area often plays a significant role in the economic viability of the area. However, it is not from this point of view that the mineral extraction industry of the Haldimand-Norfolk area was studied in this report. Rather, observations were made on the impact of the extraction industries on the esthetics and general landscape quality of the areas in which they are found. A significant factor to keep in mind is the relatively small, but important, proportion of the total area that is given over to this type of operation in the Study Area.

While several factors determine the apparent impact of any particular operation on the surrounding area, the following are vital in determining the visual quality of the extraction industry: location, topography, type of extractive industry, road access, post-extractive use, pre-planning of operations and pollution-reducing (visual, auditory and physical) practices. Unfortunately, pre-planning of operation and pollution-reducing practices were not readily apparent in the area.

The mineral extraction industry was divided into two major categories according to the type of impact on the surrounding area. The first category includes the *subsurface or shaft-type* of extraction industry of which there are two examples in the Study Area. The mineral being extracted is gypsum.

The second category is the *large open pit* extraction industry which has been subdivided into two sub-groups. The first sub-group consists of the dolomite or limestone bedrock pits. These operations all are carried out in a similar fashion and have a similar visual impact. The second sub-group consists of the sand and gravel operations which are involved in the extraction of surficial glacial deposits. These operations are grouped together because during active extraction they have a similar visual quality, both being large-scale pits of varying acreages. (These sub-groups might be placed in separate categories on the basis of post-extraction appearance and adaptability.)

Figure 12-26/This quarry near Brantford is typical of the scale and type of operation in the Study Area. The sheer bedrock walls make rehabilitation very difficult.

A final category may be distinguished from the second group primarily on the basis of size of operation and the large number of pits. This category includes small pits primarily consisting of the *working of glacial surface deposits.*

Also to be recognized is the removal or mining of soil as an economic activity. This category has a visual effect much different from the large operations mentioned above.

No attempt will be made to describe each extraction site. Rather an attempt will be made to group sites according to their operational techniques and the topographic conditions in which they are found.

Subsurface Mining

Two operations are involved in subsurface mining; the deposits and techniques of extraction are outlined in an Ontario Department of Mines[15] report and will not be described here. The deposits are located at varying depths below the surfaces and are reached by a system of subsurface chambers opening from a main shaft. There is little to be seen on the surface, therefore, except the pit head structures and processing plants. There may also be some restriction on use of land above the mined area.

Two companies are mining the same geological formation and are using the same extraction techniques. However, the visual impact of the two are different due to the topographic differences found in their respective areas. The Caledonia operation, Domtar Construction Materials Limited, is located in an area of rolling topography and is not apparent to the viewer for a considerable distance. There is no visual impression that a considerable area surrounding the plant is being actively mined. The dominant visual feature of the operation is the processing plant just off Highway 6. In general, the visual impression is more of a conventional industrial plant rather than a mining operation. The processing plant is screened from long range views by the surrounding rolling topography.

The second operation, Canadian Gypsum Company Limited located north of Hagersville, is located on a landscape less able to absorb development of this type. The plant buildings

are visible for a considerable distance due to the flatness and open nature of the landscape. However, they do not detract greatly from the general landscape quality of the area. As in the previous case, the entire extent of the mining operation is not readily apparent to the viewer. Also, the operation is some distance from the main highway.

In a general context, the visual and esthetic qualities of the operation relate primarily to the plant structures rather than to any part of the extraction process. If the structures are removed when the seams are exhausted there will be little permanent evidence of the prior activities. Permanent land use restrictions may be required over the mined-out area.

Open Pits

In the open pit category are the crushed stone quarries from which are extracted the dolomite or limestone bedrock that underlies much of the Study Area. All of the crushed stone quarries are located in the eastern sector of the area and generally correspond to the Haldimand clay plain. The depth of the quarries vary from 20 feet to 60 feet. The pits themselves vary considerably in size as well as in depth. The boundaries of the excavation are vertical bedrock faces.

The visual impact of the quarries varies with the distance from the pit. As all are located on the gently rolling to flat topography of the Haldimand clay plain it is often possible to look over these excavations without realizing they are present, particularly the abandoned ones. However, at close range the large pits are a very significant and visually intimidating feature of the landscape. From a more distant view, the processing structures and storage piles have a greater visual impact than the pit itself.

At the local scale, the large bedrock quarries overwhelm the local landscape. This is particularly evident in Hagersville where three extensive pits are found at the periphery of the town. These pits form a considerable barrier on two sides of the townsite. It is difficult to envisage these sites being rehabilitated to any useable form as bedrock quarries are more difficult to rehabilitate than are pits from surficial materials. They have become a permanent aspect of the Hagersville townsite and surrounding area and require special studies to make them into a desirable and amenable aspect of the landscape. The sheer bedrock face and flat bedrock base of these pits make them difficult to adapt for secondary use. However, some remedy for this type of landscape debilitation must be developed.

Figure 12-27/Structures and storage piles of the Cayuga Sand and Gravel Company associated with bedrock quarrying operation. In the flat clay plain landscape these elements are extremely prominent negative features.

The open pit sand and gravel operations have many of the same visual qualities as the open pit bedrock quarries. The materials being extracted are surficial glacial and fluvial deposits containing material of varying sizes and textures. As in the quarrying operation, extensive surface areas are excavated and large pits created. The configuration of the sand and gravel pits is generally less regular than that of the bedrock quarries. The pits are associated with gently rolling topography of the glaciated areas in which they are found. The rolling nature of the landscape sometimes screens the extractive operation while at other times the view is accentuated.

During active extraction, the processing plants and storage piles tend to dominate the extraction site and are the most visible element of the surrounding area. As is the case with bedrock quarries, the main impact of the pits occurs when the viewer is in close proximity to the operation. The visual impact decreases quickly in most cases with distance from the site. The offensiveness of the extraction sites is augmented because many of them are located on main highways or near urban settlements. Few, if any, attempts are made to screen these sites from the traveling public and from urban dwellers. Paris demonstrates this lack of visual screening at its worst.

Site Rehabiltation

Abandonment of these operations leaves noticeable scars on the landscape. Little effort has been made to rehabilitate these sites to other uses. The abandoned pit is particularly offensive if located near an urban area. Sand and gravel pits are much easier

Figure 12-28/Gravel pits such as this example near Paris are of significant economic importance. However, they are invariably abandoned without rehabilitation measures having been taken.

to rehabilitate for they lend themselves to grading and planting, whereas bedrock pits have vertical rock sides which cannot be graded.

Several examples of post-extractive use of gravel pits are found in the Study Area. At Waterford the Big Creek Conservation Authority has converted an abandoned pit into a functional and attractive conservation area. Also at Waterford, on the other hand, is an example of very poor post-extractive use. The town is using one of the water-filled pits as a municipal garbage dump; the site is unscreened and is located near the converted pit. This inappropriate use has resulted in a very negative visual value and contributes as well to water and air pollution.

Another serious problem is that heavily silt-laden water from washing operations in the Brantford area is permitted to enter the Grand River without undergoing settling phases. There is no enforcement in this respect by the Ontario Water Resources Commission, the Grand River Conservation Authority or the Township.

In general terms, the sand and gravel operations in the Study Area have created a highly disturbed landscape although in many cases the impact is restricted to areas in close proximity to the site. The most significant impact is created by the large pits and their completely unscreened associated buildings, and stockpiles, and by the dust and noise produced by the operation. As mentioned previously, the extraction industry has made only minimal effort to rehabilitate the derelict landscape. Rather, post-extractive rehabilitation has been done by other agencies, both public and private, who have provided the limited examples of post-extractive use. Pre-planning provisions for post-extractive use must be made mandatory within the overall development program for the extraction site.

Small Pits

There are a number of operations smaller than those previously described, so small, in fact, that they may be considered a separate category. These include numerous small active or abandoned operations scattered throughout the three counties. They do not have the dramatic effect, even on a local scale, that the large operations have.

The visual impact of these individual extractive operations is limited, except that cumulatively they have a degenerative effect on the landscape. Many are apparent only when the viewer is directly adjacent to the site. Others may be visible for considerable distances. In some cases on the flat limestone plains, abandoned quarries may have a positive esthetic value, for they are frequently water-filled and provide visual focal points on this otherwise monotonous landscape. Many old gravel pits are partially "rehabilitated" through the process of natural growth and regeneration, the vegetation tending to screen the sites and thus reduce negative visual effects. Erosion also tends to reduce the distinct edges created by the extraction.

Levelling Operations

Another extraction method is the small-scale operation which levels landforms as contrasted to the pit extraction approach. Glacial and fluvial activities often resulted in raised landforms which have commercial mineral value. An example is the removal of sand from the raised beach line created by glacial Lake Warren in Norfolk County. The old beach line forms a series of ridges which are a significant topographical feature providing the only topographical and visual relief in the southern part of the county. In some areas the sand has been removed and a levelled, monotonous landscape created. The continuity of this identifiable and limited "corridor" system could be destroyed if the extraction is allowed to proceed unchecked. Visual relief is also provided by the vegetation which is associated with the sand ridges. The ridges are seldom in agricultural use and so reduce the monotony of the tobacco growing landscape.

A second example of this levelling approach is found at Windham Centre where a gravel extraction operation destroyed a relief feature creating a flat open field. Some attempt has been made to reclaim this site by grading the sharp edges and returning top soil to

Figure 12-29/The Waterford Conservation Area is an excellent example of recreational development which is the result of rehabilitation of an abandoned sand and gravel operation.

he surface. It now has the appearance of a flat agricultural field rather than an open scar.

Soil Mining

A final example of what may be described as an extractive industry is the practice of soil mining. In this operation, the productive soil or organic layer is removed and sold as topsoil. The effects of this removal are varied. Without topsoil the site is sterilized for many forms of development. On the other hand, removal of organics may improve drainage and make the land productive. The major effects, however, are scarring by the removal of vegetation, and possible sterilization of large blocks of land.

Summary

On a regional scale the extraction industries are not an overly significant or obtrusive visual component. However, at the local scale they tend to become a particularly vital and unsightly feature of the landscape. Hagersville and Waterford bear the marks of the extensive damage which can result; both towns have large areas of essentially unuseable derelict land surrounding their built-up area — legacies of the extractive industry. One of the most objectionable features is the permanence of these scars on the landscape. Future operations should be required to prepare a development program which includes screening and rehabilitation of the site both during and after the operational phase.

There is a positive potential for some sites to be adapted to some productive post-extractive use as is demonstrated by the Waterford experience.

General Rationale

Quite apart from capability rating of land for urbanization is the suitability rating. Inherent in the suitability rating are economic and other social considerations, especially those related to more or less intangible but important human values. It should be noted here that this analysis for urban suitability is made from the point of view of landscape quality as discussed in this section only. Apart from the considerations stated in the "Rationale" at the beginning of this section, a basic premise is that *there should not be prevention of growth* but that *there should be prevention of despoliation of valuable landscape* as growth takes place in an orderly pattern. Furthermore, it should be recognized that while uncontrolled growth can bring generous profits to the land development sector of the economy, alternative controlled methods can bring not only greater returns but a high-quality environment as well.

In deriving an evaluation of landscape suitability for urbanization several kinds of considerations were made.

1) Because of the nature of the importance of landscape quality, the first priority was to identify landscapes unsuited, rather than suited, for urbanization. This approach was an outgrowth of the landscape analysis which identified those landscapes considered desirable for a variety of purposes, especially ecological, recreational and amenity.

2) Urban centers can be established in uninteresting landscapes, if sensitive use is made of land planning techniques in terms of regional landscape planning, site planning and detailed architectural and landscape design.

3) Land characteristics considered desirable for urbanization fall into two major categories. The first are related to utilitarian considerations which are physical determinants in city building such as the following: topography, which makes servicing possible at economical levels; soil and geological conditions, which affect garden culture and building of urban structures, respectively; availability of potable ground or surface water, etc. These

have largely not entered into this analysis as they are discussed in other sections of the report.

Suitability Classification
The Study Area was classified for urban suitability according to seven classes, based primarily on the character of the landscape as identified earlier in this section according to landscape personality. Class 1 is the most suitable while Class 7 is considered unsuitable (Map 12-7).

Class 1 Brantford-Norwich-Burgessville
This area is characterized by an attractive agricultural landscape and a rich variety of visual experiences afforded by a varied and interesting physiography and vegetation. Urbanization would destroy some of this landscape but skillful urban planning, urban design and landscape design applied sympathetically from the general planning to the very detailed design levels would create a highly attractive urban environment with a great deal of amenity. Important objectives would be to control strictly nucleation of urban settlement, to preserve the countryside character, and to articulate the entire landscape for recreation, appreciation and livelihood. Properly handled, this landscape has high urban absorptive capacity.

Class 2 Haldimand Clay Plain
In terms of a landscape which would disturb a minimum of valuable natural and manmade features, this area could be rated as Class1. However, as physiographic and vegetational features are important factors contributing to interesting city form and amenity, this landscape was considered less desirable than the Brantford-Norwich-Burgessville. As this area is relatively featureless, even minor landscape features would need to be preserved and articulated. The most skillful employment of planning and design techniques would be mandatory to create an interesting urban environment. The best features of plains cities should be used as models in planning and designing developments in this area.

Class 3 Norwich-Burgessville South
This is the landscape personality lying in the area south of the Norwich-Burgessville line between the clay plain and the Big Creek valley. The greater variety of landscape types some of which have high interest make it less suitable for urban development than the area described as Class 2.

Class 4 Norfolk Sand Plain
While the quality of the natural landscape is low this area is a very rich cultural (*i.e.,* agricultural) landscape characterized by attractive and orderly farmsteads, a great variety of interesting agricultural crops and rich contrasting tree vegetation in the form of windbreaks, hedgerows, coniferous and deciduous woodlots, making the area rate high for landscape value. This rich countryside should be considered a valuable cultural resource which can complement and enrich urban living experience.

Class 5 Lake Erie Shore and Grand River Valley
The high landscape value of these natural corridors is well documented. It is based on the importance of water, especially in large bodies, as a prime recreational resource; it is augmented in many places with unique or large vegetational and interesting landforms. As the Study Area has a large hinterland beyond the water bodies which will undoubtedly be part of a major megalopolis, it is important that the land in this class remain in open space in perpetuity.

Class 6 Major Creek Valleys and Tributaries
This class includes primarily the Big Creek and Big Otter Creek valleys, their tributaries and contiguous uplands. These areas might have appeared in the same class as the Lake Erie Shore and Grand River valley except that they have less absorptive capacity for urban uses, their vegetational and physiographic features making them unsuitable for urbanization. As with the Grand River valley, these valleys will assume immense importance as an inland "breathing space" as the population of this and other parts of Ontario increases.

Class 7 Long Point and Turkey Point
The outstanding scenic and ecological characteristics of these areas render them completely unsuitable for urban use.

Summary and Recommendations

1) Any rationale for the planning and development of a region must recognize the ecological nature of man and his environment for he cannot attain either physiological or emotional health in an environment in which all organisms and their physical base are not in balance. In this section on Landscape Quality it was the objective to conduct an inventory of the landscape in its totality and to analyze it from a qualitative point of view. It was the further objective of this analysis to identify the positive and negative values of the landscape and as a result to recommend action for its preservation, development and redevelopment. Special recognition was given to the fact that while prospective major economic development in the Study Area can bring decided material benefits, such development can also surely destroy the quality of life it seeks to achieve.

2) The field work for this study was conducted essentially by the windshield survey method during which most of the roads in the area were driven and landscape resources and land developments were noted.

3) As diversity and contrast are of major importance in contributing to regional interest, the Study Area was classified into 7 landscape personalities. The Long Point spit is by far the most striking while the clay plain landscape is the least interesting. The features peculiar to each of the landscape personalities should be recognized as a guide to their future development.

4) Analysis of concentrations of natural and manmade landscape resources identified 5 major environmental corridors including the Lake Erie shore, the Grand River valley, the Big Otter Creek valley, the Big Creek valley, and the Sandusk Creek valley and its tributaries. A number of environmental nodes were identified as well. These corridors and nodes must be recognized as major resource areas which should receive priority consideration in any proposed development schemes of regional significance and explicit policy should recognize these phenomena.

5) The major water features are the Lake Erie shore, the Grand River, and the Big and Big Otter Creeks and their tributaries. All are characterized by exceedingly large recreational development potential and also by lack of long-range comprehensive planning to assure full realization of this potential. Nowhere is there evidence of careful site planning with the result that recreational and certain other developments are of a particularly low order contributing, apparently, to a decrease in certain kinds of recreational activty.

6) Erosion of the Lake Erie shore poses major physical and legal problems both of which should be investigated in some detail in view of the pending large industral developments. If the legal problem has not already been clarified, common law prohibition should be investigated. Information on the overall erosional pattern should be collated and detailed engineering studies undertaken if necessary. Lastly, proposed major harbor works should show beyond doubt that damage to neighboring properties and to Turkey and Long Points and the area beaches will not be caused through elimination of erosion or through changes in erosional patterns.

7) The minor water features are also important, especially in the plains areas where they provide not only visual relief but potential for recreational purposes. Turbidity caused by pasturing livestock, field erosion and tree cutting is a prevalent problem causing fish mortality and unpleasant visual quality. It is important to study this situation with a view to establishing mandatory conservaton practices involving cooperation between land owners and government.

8) There are few natural inland lakes but several have potential for public recreation development. Water quality varies from the extensively polluted Mohawk Lake to Colles Lake which is good.

9) The wetlands of the Study Area are rich as well as unique in locations for migratory species and species on the northern or southern fringe of their range. For these reasons, and because wetlands are a scarce resource in southern Ontario and the Study Area, all of the existing wetlands should be retained for ecological, recreational and water catchment purposes.

10) The area is not well endowed with unique or dramatic topographical or geological features which are normally basic to distinctive regional character. The Grand River valley, the Lake Erie bluffs and the river valleys of Norfolk County are important, especially as they are related to major water features. The dune lands and parallel sand ridges of Long Point and the Sand Hills near Port Burwell are outstanding. The flat clay plain of Haldimand County is monotonous for lack of relief.

11) The Study Area is an integral part of the Carolinian Area of the Upper Austral zone which is important to phytogeographers, botanists and recreationists, for its flora is not found anywhere else in Canada. In this small area there are a large number of plant and animal species which have their other limit of range in the southern states of the United States. This unique situation has not been exploited for interpretive purposes in the Study Area.

12) The major vegetational features are the large swamplands of Canborough, Burford and Oakland, and the Grand River and Big Otter and Big Creek valleys. Others are county and conservation authority forests and provincial parks. Tree-lined roads, hedgerows, windbreaks and farm woodlots are particularly important as a visual amenity in the very flat sand and clay plains area. The Backus Woods is an important Carolinian forest type which warrants careful disposition. Long Point is an area of dramatic contrast of landform and vegetation.

13) No archaeological work has been conducted in the area but authorities feel investigations into past Indan cultures would bring valuable results. There are no remains of early white settlement but Fort Norfolk should be considered for reconstruction.

14) The Study Area, especially the Grand River corridor and Norfolk County, is rich in period architecture of a quality worthy of preservation. The village of Vittoria should be studied by the Canada and Ontario governments with a view to developing it into a center of early architecture and landscape of national significance. Vienna should be considered for special local preservation measures.

15) As there has been no large-scale urban growth all towns have a great deal of distinctive architectual quality. It is important that during rehabilitation and modernization this character be preserved and that policy be established to encourage and make possible this kind of architectural conservation. Additional policy should be established to make architectural preservation possible.

16) Little air and sound pollution is evident. Water and visual pollution, however, are evident everywhere and are significant factors in detracting from a wholesome landscape experience. Large industrial complexes are already exerting a profound local influence in the flat plain landscape. Architectural and landscape design review by public agencies should be mandatory for these projects and for such structures as rural indoor production units, as it is in the United Kingdom and other countries. As conventional urban and regional planning has not solved this general problem in Ontario or elsewhere special provincial legislation should be considered.

17) Industrial development is not extensive throughout most of the area but where it has occurred — namely at Port Maitland and Brantford — its effect on the environment has been deleterious. This non-planning and lack of environmental control should not be allowed to take place in future urban development.

18) The urban quality of the towns in the Study Area is generally good. Simcoe, especially, is of province-wide significance for its recognition and development of the Lynn River and its environs as a civic open space. Existing and future towns should recognize their river valleys similarly. Brantford, Dunnville and Tillsonburg are among the more important examples of larger towns which have negated their river-oriented location. A number of smaller towns also have not taken advantage of their river valley locations. Future development policy in these towns should recognize this major natural resource advantage.

19) There is no urban center in the Study Area which can be considered as a model for development of its beaches and related facilities. Port Dover possesses particular potential in this respect as does Port Burwell. However, major policies and programs must be developed to achieve the renewal required, which should be on the scale of conventional urban renewal schemes. Lake fishing, boat-building and marina activities should be an integral aspect of such schemes.

20) The ethnic composition of the Study Area is hetergeneous, particularly in Brant and Norfolk Counties. Encouragement should be given the various groups to express themselves and thereby give the area regional cultural interest. This applies particularly to the Indian culture of the Tusacarora Reserve, the United Empire Loyalist architecture and the variety of ethnic groups in the Delhi area.

21) Cottage developments pose special problems in respect to pre-emption of prime recreation lands some of which should be in public ownership. Most of the cottages are along the Lake Erie shore although some are located along the Grand River. Many are of slum-dwelling quality and a growing number are becoming year-round residences. This problem is aggravated by water pollution and poor sanitary disposal. A thorough analysis should be made of this problem as it is affected by future population growth in the area, especially from the point of view of site development and building standards. Also, the advisability of relocation into planned cottage subdivisions should be studied in areas of prime sites required for public recreation.

22) Fishing ports and marinas along Lake Erie are an important recreational attraction. Neither have been integrated into recreational plans; marinas vary greatly in quality.

23) In comparison to its upper reaches, the lower Grand River is relatively undeveloped for recreation. In view of prospective increased industrial development there is now increased validity to the 1968 economic feasibility study of the Department of Tourism and Information to establish a recreational waterway between Port Maitland and Newport. Such a project would entail the construction of 5 dams and locks by different levels of government. This proposal should be re-examined immediately.

24) Mill ponds, dams and canals are historical water features which should be conserved and rehabilitated. Most important of these is the old Welland Feeder Canal between Dunnville and Welland.

25) While the private sector will continue to hold an important role in the recreation industry it cannot fulfill the expanding and more sophisticated needs of the future. Advisory and perhaps financial assistance should be made available to entrepreneurs in order to upgrade the frequently low standard of services and facilities.

26) There is little evidence that the stepped-up shoreline acquisition policy announced in the Speech from the Throne in 1962 has been implemented. In view of pending expanded development, this program should be greatly accelerated.

27) There is serious lack of a progressive provincial parks policy in the Study Area. There is neither long-range systems nor site planning, nor is any anticipated except a needs analysis at the provincial level. Site and facilities design is of a particularly low order and maintenance is poor due to allocation of insufficient funds. Systems planning must be

undertaken within and outside the Study Area from the national through to he local level. Park development prototypes in other parts of Canada and in he United States should be studied vith a view to undertaking radically iew and progressive approaches.

28) Two established provincial parks vere examined to identify the nature of roblems being experienced in this type f park and to suggest long-range solutions from a prototypal point of view. Serious problems exist in the form of bsence of overall long-range planning nd site development master planning, ncompatible land uses, facilities and affic design, sanitation and negation of ndscape values. An especially serious roblem stems from the location of rivate cottage development of a most ariable quality within the park oundaries presenting serious problems f incompatability between cottagers nd park users. This condition is aggrated by lack of control over billboards, ommercial and residential establishents, cottage expansion, sewage disosal and parking areas. Also, fisheries serves are a "no-man's-land" with either the townships nor the Parks ranch claiming responsibility to gulate their use or carry out the surillance and maintenance being manded by the minority cottage users. part from the need for comprehensive tailed planning, a program of preption or relocation of these cottages thin the parks must be examined. ottagers have been successful in warting government proposals geared benefit the majority of the public.

) Conservation authorities do not pear to have sufficient funds, or are willing to allocate them, for an panded and more sophisticated park d recreation program. While the isting county parks are providing eful services, future local governnt must be prepared to move quickly d boldly to supply greater park areas ering a wider range of more sophisticted services. A blue print for mplementary or amalgamated vices will need to be worked out at an ly date between regional government and the conservation authorities.

30) Long Point spit is a particularly spectacular and distinctive physiographic-ecological landscape, characterized by an extensive and continuous beach, dunes, marshes, landforms, deciduous forests and variety of unique flora and wildlife. Because of these features and because of its ecological instability, Long Point should be developed as a National Landmark under the jurisdiction of the National and Historic Parks Branch with rigid controls governing its use for interpretive education and scientific study.

31) The lakeshore between Port Dover and Port Rowan and the Big Creek and Big Otter valleys and their related uplands comprise the finest landscapes in southern Ontario. Because of their quality and relatively undeveloped state they should be singled out for special planning consideration. This includes the particularly interesting rural landscape of this area.

32) An immediate study should be undertaken to identify in detail railways, abandoned or about to be abandoned, which may have usefulness for local or regional recreational purposes. The provincial government should undertake discussion with railway companies to express its interest in receiving priority claim when rights-of-way are to be sold.

33) There are no parkways or scenic highways although the potential is high and the need obvious. Existing road locations do not permit appreciation of scenic views, especially of such major landscape features as the Lake Erie shore, the Grand River and other major valleys. Also, there is need for rest areas within the existing road system.

34) There is a priority need, as part of a comprehensive recreational system, to study the integration of several separately recommended parkways into one system for southern Ontario. This would involve a "Lake Erie Shore Parkway" beginning with the St. Clair Parkway in Sarnia in the west which might connect with the Niagara Escarpment Scenic Drive and the Niagara River Scenic Drive in the east. In the Study Area the system would include parkways in the forelands of the Lake Erie shore, the Grand River valley and the Big Creek valley with a possible connection of the last 2 along Whiteman Creek. Legislation should be considered to create "Special Park Districts" along these routes to preserve the landscape in compatible use.

35) The absence of a comprehensive transportation plan appears to have resulted in multiple and incompatible functions of a number of highways and roads, particularly Highway 3. One of the major problems is that highways are frequently the main streets of towns and villages that should have been bypassed.

36) Road widening projects have destroyed both countryside character and urban amenity and convenience. Greater recognition should be given these matters in future road design which should include roadside rehabilitation measures as an integral part of this program. Because pleasure driving is an important recreational activity, country roads should be recognized for this purpose and roadside development policy should be established to articulate this purpose.

37) Immediate planning policy must recognize growing residential subdivisions and increasing numbers of single residences along the Grand River in order that countryside character or recreational potential is not irrevocably destroyed.

38) Residential and commercial strip development has occurred to a significant degree even though the area is not highly urbanized. There is need for planning in this respect and for more effective site development controls to achieve efficiencies and preservation of countryside character by promoting urban nucleation.

39) A specific program of countryside environment preservation should be undertaken as an important positive landscape value of benefit to present

and future urban and rural residents of the area. European legislation and programs should be studied as prototypes in this respect.

40) Surface mining, not having been subject to government or self-imposed controls, has had a significant effect in producing a highly disturbed landscape. Both government and the private sector share the blame for this problem. The result is physical scarring, some of which cannot be overcome, in extensive areas near urban centers. Neither local government, the Ontario Water Resources Commission nor the conservation authorities enforce provisions to prevent release of turbid water from washing operations into streams and rivers.

41) There are no pre-planning measures to minimize negative effects of on-going operations and also for post-extractive rehabilitation and use. Such measures must be undertaken immediately.

42) Extractive operations are eliminating interesting landforms in the plains area accentuating the problem of monotony in this flat landscape.

43) Post-extractive rehabilitation and use varies from such ideally developed uses as public recreation to that of the dangerous practice of dumping refuse into water-filled sites which could result in serious contamination of water aquifers.

44) Soil mining has resulted in the possible sterilization of large blocks of land. Conservation measures should be enacted to protect the topsoil that is a byproduct of building operations.

45) A comprehensive inventory program of detailed landscape resource identification should be undertaken by the residents of the Study Area, as has already been done for architecture by the University Women's Club of Norfolk County. It should include all items of historical/conservation/cultural value and should have tangible support from local and provincial governments.

46) The Study Area was rated for urban suitability according to 7 classes; these classes generally coincided with the landscape personalities identified as a result of the field inventory. A basic premise of the rating was not that growth should be prevented but that despoliation of landscape should be prevented by making growth follow an orderly pattern. Other premises were that landscapes with high ecological, recreational and amenity values were unsuited to urbanization and that sensitive planning and design techniques can render less interesting landscapes suitable for urbanization.

47) Special planning attention will need to be given to location of transportation, communications and utility systems to increase efficiency of land use, reduce negative landscape and social effects, and to create multiple-function utility easements. Large multi-purpose corridors should not be attempted until the incompatibilities and dangers of noise, esthetics and hazards are resolved through broadly based planning and design research.

Footnotes

1. The basis of this list is from "A Citizen's Potomac Planning Guide" prepared by the Conservation Foundation. Certain planning subjects were deleted and numerous ones added to reflect characteristics peculiar to the Study Area.
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6. Fox, W. Sherwood and James H. Soper. "The Distribution of Some Trees and Shrubs of the Carolinian Zone of Southern Ontario", *Trans. of the Royal Can. Inst.,* 1952, 1954, 1955.
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8. Landon, Monroe. *Vascular Plants of Norfolk County, Ontario,* Big Creek Conservation Authority, 1960; and Cruise, James E., "A Floristic Study of Norfolk County, Ontario", *Trans. of the Royal Can. Inst.,* Vol. 35, 1969.
9. Visual pollution is defined here as that being offensive to the eye (for example, litter and garbage), and does not include the physical-chemical aspect of pollution.
10. Classification of natural resources and manmade resources is shown in Appendix D, together with the field inventory of these resources.
11. Such a precedent has been established by the State of Kentucky which offers a high standard of a wide range of services including a variety of accommodation at reasonable prices and facilities such as marinas, tennis courts, swimming pools and beaches, riding stables, restaurants, etc.
12. Jackson, John N. *Recreational Development and the Lake Erie Shore,* Niagara Regional Development Council, 1967.
13. Klopchic, Peter. *Feasibility Study of Recreational Boating on the Grand River,* Ontario Department of Tourism and Information, 1968. Dr. Klopchic's study was carried out in 1968 prio to knowledge of industrial growth in the Study Area. Therefore, even greater credence should be given to the study than at the time it was published.
14. Detailed description of these resources appear in other sections, especially in

Landscape Inventory (natural and manmade).

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Keith Cameron, Donald Johnson, Malcolm McKenzie, Raymond Turner, E. G. Wilson, Lake Erie Forest District Headquarters, Aylmer.
Thomas L. Beck, Superintendent, Long Point Provincial Park and Jack Sulston, Superintendent, Turkey Point Provincial Park.
W. C. Harris, President, Long Point Company.
Mr. and Mrs. W. M. S. Smale, Architects, Simcoe.
Craig Edwards, Resource Manager, Otter Creek Conservation Authority.
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Index of Terms

Meteorology:
The study of weather.
Micrometeorology:
The study of weather processes with dimensions of a few hundred yards or less.
Mesometeorology:
The study of weather processes with dimensions of one or a few counties.
Macrometeorology:
The study of weather processes with dimensions of a continent.
Climate:
The totality of weather.
Inversion:
An increase of temperature with height.
Free convection:
Buoyant upward motion when air is heated from below.
Moraine:
Debris deposited by glaciers.

Regional Air Pollution Simulation Models

Introduction

In the early days of air pollution control, a primary objective was the reduction of black smoke, fly ash and sulphur dioxide emission from chimneys. The control officer compared the color of the smoke with that given on a Ringelman chart while the sulphur dioxide was monitored by sampling the flue gases in the chimney. A violation occurred when specified threshold values were exceeded.

More recently, the emphasis has shifted from emission standards to air quality criteria. With multiple sources and many different chimney heights, legislation is often framed in terms of ground-level concentrations rather than on the amounts of pollution coming from each chimney. Because the atmosphere provides some turbulent dilution, emissions from a single 500-foot chimney may have less influence on ground-level air quality than do emissions from a number of 50-foot chimneys.

Of recent interest too are emissions from automobiles, which may produce high concentrations of carbon monoxide, hydrocarbons and nitrogen dioxide directly, and oxidants indirectly (by photochemical reactions).

Air pollution agencies in most countries now regard air quality as a regional problem. Pollutants are no respectors of municipal, county or even national boundaries.

An indication of the current interest in the regional approach is the fact that an international symposium on pollution simulation models was held at the University of North Carolina in October 1969. Scientists from the United States, Canada, England, the Netherlands, Germany and Japan attended. This appendix incorporates the views of that meeting.

Historically, the first attempt to model multiple sources was carried out in the Los Angeles basin by Frenkiel (1956). More recently, models have been developed for the state of Connecticut (Bowne 1969), the Washington to Boston "megalopolis" (Slade 1967), New York, Chicago and elsewhere.

Pollution From a Single Chimney

For a short interval of time (ten minutes or less) and on a single occasion, the ground-level concentrations downwind from a single chimney cannot be predicted accurately. Over flat open countryside and averaging over many occasions during similar weather conditions, however, the concentrations can be estimated satisfactorily.

The model most widely employed assumes that the plume from a chimney spreads in the cross-wind and vertical directions in such a manner that the distributions of concentrations are Gaussian, with standard deviations in the lateral and vertical directions denoted by σ_y and σ_z. The Gaussian spread is rarely realized on a single occasion but, by the Central Limit Theorem, the assumption is reasonable for long averaging times.

The resulting equation (See Munn 1966, p. 118 for a detailed discussion) is as follows:

$$C = (Q/\pi u \sigma_y \sigma_z) \exp(-y^2/2\sigma_y^2) \cdot \exp(-h^2/2\sigma_z^2)$$

where the reference frame is such that x is in the direction of the wind, y is in the cross-wind direction, and the chimney is at the origin ($x=0$). In this equation,
C is the ground-level concentration of pollution,
Q is the source strength,
u is the average wind speed over the layer of concern
h is the height of the chimney (cold plume).
To obtain the plume centre-line concentration ($y=0$), the equation may be simplified to:

$$C = (Q/\pi u \sigma_y \sigma_z) \exp(-h^2/2\sigma_z^2)$$

The buoyancy of hot flue gases causes them to rise upward several hundred feet at least on occasion. The quantity h then becomes the height of the plume rather than the height of the chimney.

Over flat open countryside, metho are available for estimating σ_y, σ_z an h from a knowledge of weather conditions. The most widely used procedure is that of Pasquill (1961), combined with any one of the multitud of formulae for estimating buoyant plume rise.

Table A-1/Average Changes in Climatic Elements Caused by Urbanization (Landsberg 1962)

Element	Comparison with rural environment
Contaminants	
condensation nuclei and particulates	10 times more
gaseous admixtures	5-25 times more
Cloudiness	
cover	5-10% more
fog, winter	100% more
fog, summer	30% more
Precipitation	
totals	5-10% more
snowfall	5% less
Relative Humidity	
winter	2% less
summer	3% less
Radiation	
global	15-20% less
ultraviolet, winter	30% less
ultraviolet, summer	5% less
sunshine duration	5 to 15% less
Temperature	
annual mean	1.0-1.5°F more
winter minima (average)	2-4°F more
heating degree days	10% less
Wind Speed	
annual mean	20-30% less
extreme gusts	10-20% less
calms	5-20% more

The method fails when winds are calm or light variable.

The Regional Multiple-Source Problem

The first step is to undertake a source inventory, identifying each tall chimney and also estimating the emissions of sulphur dioxide from each urban residential block. This is a very difficult exercise, requiring knowledge, not only of the annual emissions, but also of the seasonal, weekly and diurnal patterns.

In the case of automobile pollution, traffic density must be determined, and the emissions estimated for each hour of the day.

Having decided on appropriate values of source strengths Q and heights h, the equations in the previous section are solved numerically on a computer for each source and summed to yield the composite ground-level patterns resulting from the multiple sources.

There are some difficulties (to be discussed later) in estimating the time and space variations in σ_y, σ_z and u.

The next step is to "verify" the model by comparing the predicted values of ground-level concentrations with those observed from a network of sampling stations. When reasonable agreement is obtained, the effect of industrial expansion or changing land use is simulated by merely varying the source strengths and reprogramming the computer.

The memory of computers is becoming so large that a very dense grid can be treated. In the most recent New York City model (Shieh *et al.* 1969), for example, an area of clean air is predicted in Central Park, as might be expected. Nevertheless, it must be admitted that advances in computer technology are far ahead of those in the physical understanding of mesometeorological diffusion processes. The first-generation models often assume that meteorological conditions are constant in space and time. When regional variations in wind are included, the data are obtained from networks of surface anemometers, and do not necessarily reflect the wind patterns at a height of 1000 feet or so. Mesometeorological circulations such as lake breezes and valley winds are usually ignored, while the calm wind case (potentially the most serious for poor air quality) cannot be studied.

In fairness to existing models, a number of "sensitivity" tests are undertaken at the verification stage. The meteorological and source strength input data are deliberately varied by perhaps 50 percent and the computer program is rerun. This permits study of the effect of input uncertainties on the resulting predictions. Both random and systematic variations have been examined by Hilst (1969), who finds that random errors in source strength have little effect on air quality predictions. In addition, the models are not sensitive to values of σ_y, the cross-wind spread.

The models described so far apply to relatively short periods of time (usually six hours or less). To extend the calculations to longer intervals, three main approaches are used:

a) *The method of Fortak (1969).* Weather conditions are subdivided into a number of classes, usually those of Pasquill (1961); *e.g.,* nighttime clear skies with light winds; nighttime cloudy skies; and windy, etc. A separate regional prediction of concentrations is made of each class. Then, from knowledge of the climatological frequencies of these various meteorological conditions, a simple weighting procedure yields average pollution concentrations and their frequency distributions at each point in space. Fortak has tested his method in the city of Bremen, Germany.

b) *The expanding puff method.* The emission from a chimney is assumed to consist of a series of puffs. Each puff expands and is carried forward in response to the local wind and turbulence. This permits the inclusion of meteorological conditions that vary in

space and time. The method has been used in the Chicago model and has been described by Roberts *et al.* (1969).

c) *The K-theory method.*

This method is attractive in principle but has not been widely used. It is based on an assumpton of similarity between the transfer processes of momentum and matter. From a prediction of the three-dimensional evolution of the wind field, the diffusion of pollution can be studied in a time-varying situation. The equations (above) assume that the wind is constant with height, whereas in fact there is an increase and veering with height. Pasquill (1969) has discussed the method while Randerson (1969) has attempted some numerical solutions on a large computer.

Relevance to the Haldimand-Norfolk Area

Because the Haldimand-Norfolk area is still largely rural, a model cannot be "verified" with observed ground-level concentrations in that region. Models verified elsewhere have built-in biases to match local conditions, and an investigator is ill-advised to apply them directly to the Haldimand-Norfolk area, except for purposes of comparision.

The general approach of Fortak (1969) is recommended. The "pollution climate" of the region should be subdivided into a number of weather types, and the frequency of each should be determined. For an assumed source-strength distribution then, the regional pollution patterns for each weather type should be calculated, from which average values and frequency distributions at each point can be obtained readily. The upper tail of the pollution frequency distribution will, of course, be missing since these cases are associated with spells of light winds lasting several days; situations occurring perhaps once every 20 years when air quality deteriorates seriously. Nevertheless, light wind duration studies will at least predict the frequencies of these rare events.

The critical step in this general approach is the estimation of ground-level concentrations for each of the weather types. The results presented in the main body of this report on the mesometeorology of the Study Area provide some clues on how to proceed. However, additional research is required on modelling the three-dimensional atmosphere in that particular region, particularly the perturbations caused by Lake Erie and by industrial and urban heat islands.

Table A-2/Comparison of Three-year (1965-67) with 30-year (1931-60) Climatic Averages

Station	Averaging Period (Years)	Maximum Temp. June-Sept. (°F.)	Minimum Temp. Dec.-Feb. (°F)	Annual Snowfall (inches)	Monthly Rainfall (inches) May-Aug.
Delhi	3	76.7	19.0	45.5	2.6
	30	77.7	17.8	57.1	3.1
Caledonia	3	74.7	18.7	45.6	2.1
	30	77.4	17.0	43.9	2.7
Brantford	3	75.9	20.2	48.1	2.5
	30	78.2	17.7	48.1	2.6
Port Dover	3	74.9	20.7	44.5	2.5
	30	76.7	18.3	40.7	2.5

Table A-3/Annual and Monthly Numbers of Hours of Sunshine Based on 30-year Period 1931-60.

Station	Annual	J	F	M	A	M	J	J	A	S	O	N	D
Delhi	1815	62	88	115	153	206	234	268	238	171	145	77	58
Woodstock	1970	68	98	126	166	224	261	286	253	189	156	80	63
London Airport	1936	63	91	128	165	231	238	283	256	184	156	79	60
Kohler*	1754	63	74	102	145	201	231	251	227	164	150	86	60
Vineland	2047	74	101	137	174	229	263	289	261	194	164	92	69

*Kohler records are for the period June 1947 to August 1967.

Table A-4/Wind Speeds Associated with Very High and Very Low Temperatures at Simcoe, 1964-66.

Wind Speed (mph)	Number of Hours with temperatures above 85°F	Number of Hours with temperatures below 0°F
1 — 5	11	17
6 — 11	52	40
12 — 17	46	43
18 — 23	7	9
+ 24	0	0

Diffusion Calculations to Estimate Desirable Separation Distances

The following is a discussion of diffusion calculations used to estimate desirable separation distances between heavy industry and residential-agricultural areas.

The Gaussian equation is generally accepted as the model for the calculations of ground-level concentration from a continuous point source. For ground-level center-line concentrations,

$$C(x) = (Q/\pi\sigma_y\sigma_z U) \exp -\tfrac{1}{2}(H/\sigma_z)^2$$

where

C(x) — the ground-level concentration at some point (x) down wind (meters)

Q — the source emission strength (gms/sec)

σ_y — the standard deviation of the plume spread in the cross-wind direction (meters)

σ_z — the standard deviation of the plume in the vertical (meters)

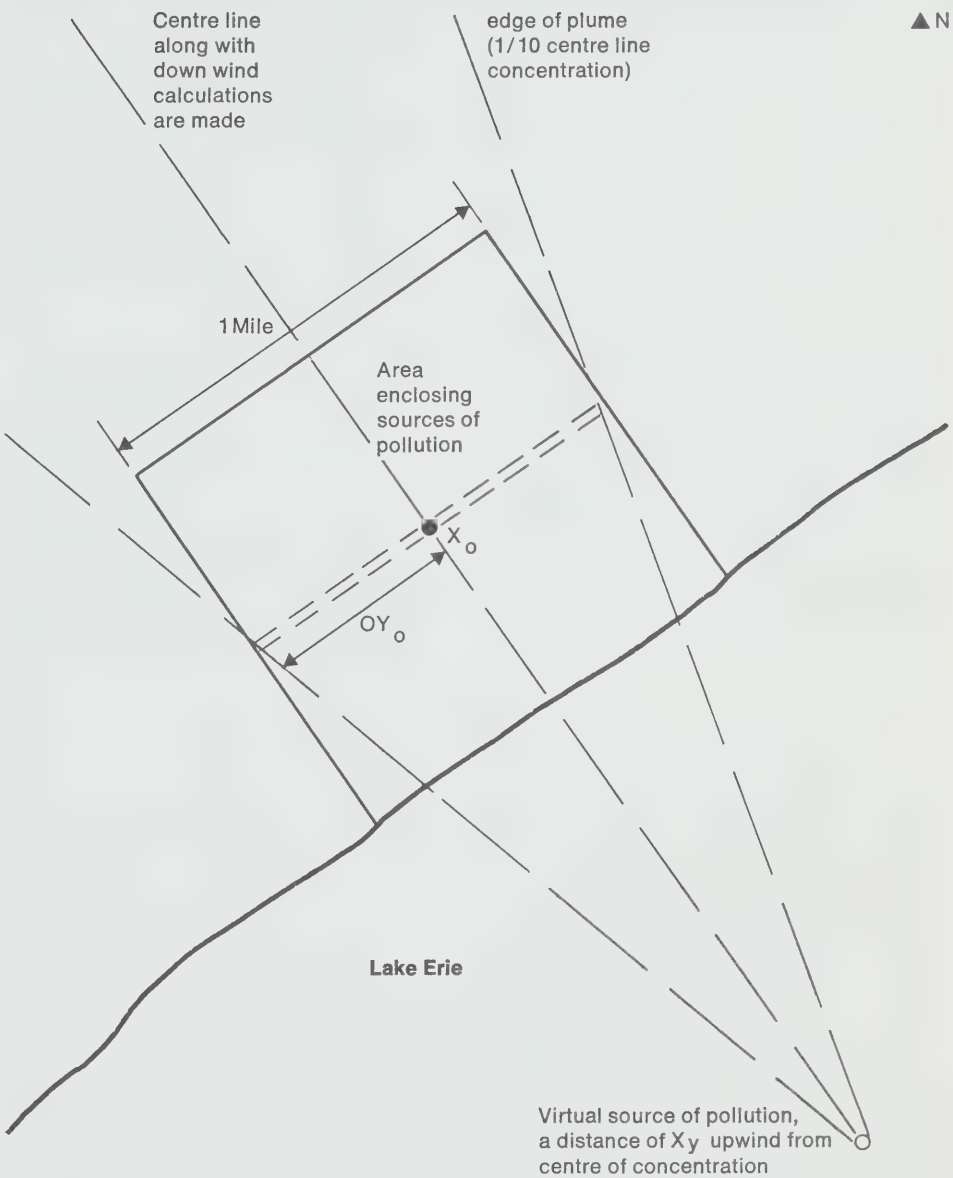
H — the effective height of the plume (height of chimney plus plume rise) (meters)

U — the average wind speed in the layer of concern (meters/sec)

Any consistent set of units can be used with the above equation. For simplicity, the metric system of units is used in the following example. The corresponding value in the English system is shown in brackets in the text and, where necessary, in Table A-1. Sulphur dioxide will be used as the pollutant because many air quality criteria specify the maximum concentration of this particular gas.

A technique for the calculation of ground-level concentration down wind from an area source is as follows. Assume an industrial complex enclosed by an area of one mile square, and sulphur dioxide emission rate of 5.25 10^3 gms/sec (500 tons/day). This is a reasonable estimate of the amount of

Figure A-1/Schematic Showing the Virtual Source of Pollution Emitted from an Area One Mile Square. The Chimneys within the Area Are Assumed to Be Concentrated at the Center of the Area.



sulphur dioxide released from a heavy industy area of this size. Assume also that the mean effective height of emission H from the industrial complex is approximately 260 meters (849 ft) and that the mean wind speed $U = 5$ m/sec (11 mi/hr). Again these are reasonable order-of-magnitude estimates.

Using the technique described in the Workbook of Atmospheric Dispersion Estimates (Wade 1968), the variables σ_y and σ_z can be estimated for various downwind distances from the source. Since it is difficult to work with an area source, a virtual source is calculated assuming that the chimneys in the enclosed area are concentrated at the center and that the initial cross-wind distribution $\sigma_{yo} = S/4.3 = 375$ meters (1232 ft.). Using this value, the virtual source (x_v) is found to be 4.3 km (2.68 miles) upwind from the center of the area. Figure A-1 shows a schematic representation of this configuration. Table A-1 presents the results using the equation shown above for center-line concentration.

The concentrations C at the extreme right of the table are plotted on semi-log graph paper (Figure A-2) as a function of down-wind distance x from the center of the area of concern. A maximum concentration of 1.1×10^{-3} gms/m^3 (0.38 ppm) occurs at about 5 km (3 mi) downwind. This value is within the present Ontario government regulations for permissible ground-level concentration (0.40 ppm) within an industrial/commercial land use area. The requirements, however, for residential and rural land use are for concentrations no greater than 0.25 ppm. This value occurs at approximately 7 km (4.4 mi) downwind (see Figure A-2).

It is thus recommended that an area should not be zoned residential or rural within at least 4.4 miles of a one square mile area emitting approximately 500 tons of sulphur dioxide per day.

It is to be noted, that if one graphs the value CU/Q, the second column from the right, against downwind

Figure A-2/Ground-level Center Line Concentration as a Function of Downwind Distance.

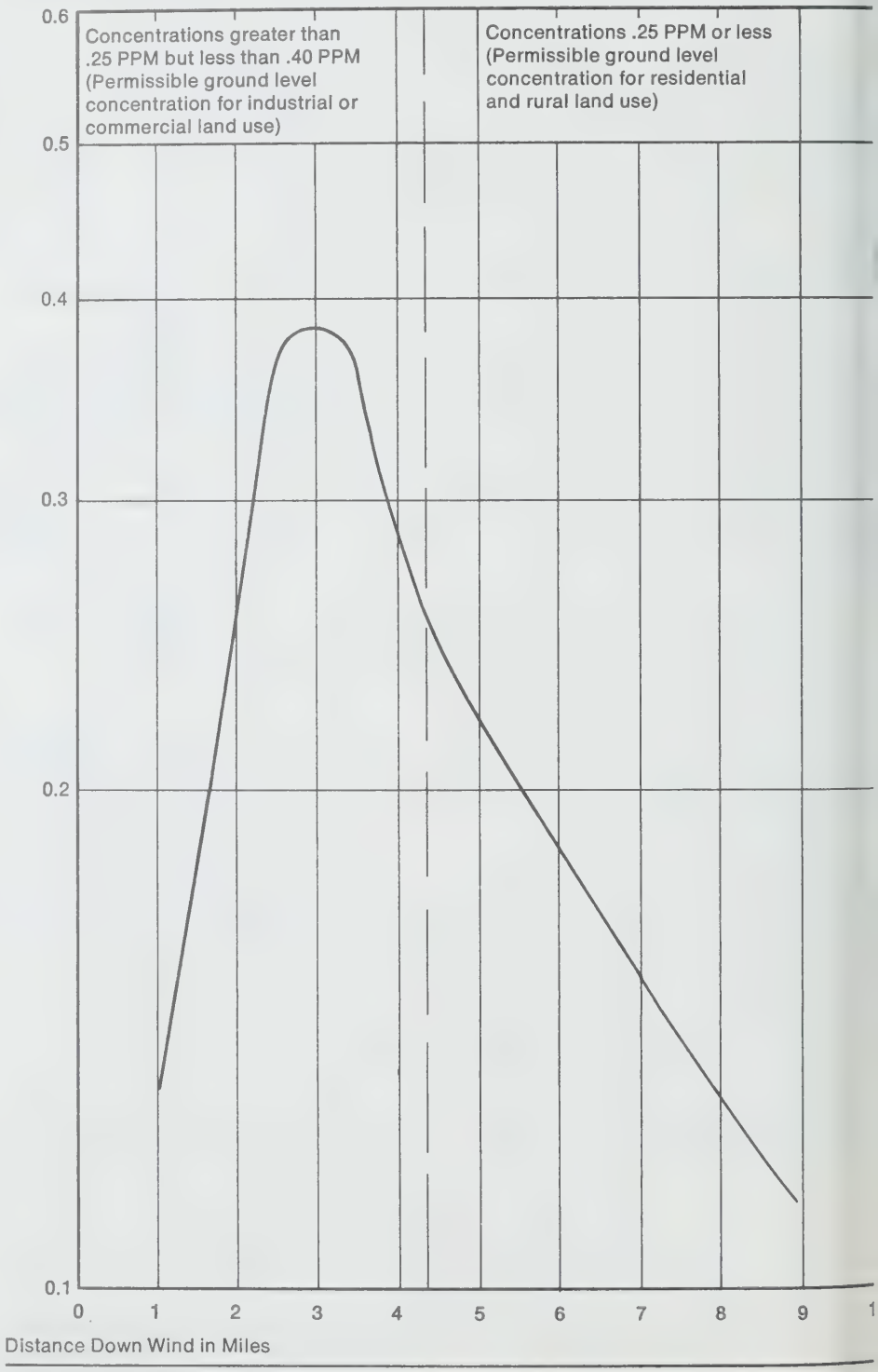


Table A-5/Comparison of Frost Conditions at Several Locations Within and Around the Study Area.

	No. of Years Considered	Average Frost-Free Period (Days)	Last Frost (Spring) Average	Earliest	Latest	First Frost (Fall) Average	Earliest	Latest
Caledonia	19	142	May 14	Apr. 20	June 8	Oct. 3	Sept. 12	Oct. 25
Dunnville	3	157	May 6	May 1	May 10	Oct. 10	Oct. 6	Oct. 16
Vineland	25	175	Apr. 28	Apr. 11	May 21	Oct. 20	Sept. 28	Nov. 6
Simcoe	43	135	May 17	Apr. 20	June 8	Sept. 29	Sept. 4	Oct. 24
Port Dover	51	155	May 8	Apr. 2	May 29	Oct. 10	Sept. 12	Nov. 2
Brantford	63	142	May 13	Apr. 9	June 23	Oct. 2	Sept. 10	Oct. 6
London	58	138	May 16	Apr. 17	June 16	Oct. 1	Sept. 9	Oct. 28
Delhi	16	133	May 19	Apr. 13	June 8	Sept. 29	Sept. 5	Oct. 13

distance, one can easily calculate the downwind concentration as the emission Q from the enclosed area changes. The necessary rezoning can thus be estimated.

The recommended separation distance is supported by an analysis of Clarenburg (personal communication) of odor complaints in Rotterdam, The Netherlands. After normalizing for population density, Clarenburg finds that the frequency of odor complaints drops to one percent of its close-in value at a distance of 8 miles from an area of heavy industry.

Note: The regulations Made Under the Air Pollution Control Act, 1967 (Ontario Regulation 130/70) give the various standards for concentrations of air contaminants. Schedule 1 states that for a plant emitting SO_2, the concentration emitted shall not be greater than 0.30 ppm averaged over a period of 30 minutes at the point of impingement. Schedule 2 gives the ambient air quality criteria for air contaminants. For SO_2, the amount measured in the atmosphere shall not be greater than 0.25 ppm for a one-hour average.

Reference — Wade (1969) Workbook of Atmospheric Dispersion Estimates. U.S. Department of Health Education, and Welfare.

Tally Sheets of Tree Species for Original Surveyors Notes

Chart B-1/Absolute Frequency Association; County — Brant; Township — Burford; Surveyor — J. Stegman, 1798

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ob	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po	Ma
Mh	132*	79	2	6			125	80																										
Be	11	13*		2			8								1																			
C			7*	5					2						3																			
Pw	27	40	1	57*			5								9																			
Ce					12*	7							1																		2			
Ab					3	181*	47	5				2																							
E	20	14		7		3	27*	5																										
Bd								•																										
Ow									48*										1										47					
W										8*																								
Ha											•																							
Ms		2										4*																						
He													3*																			1		
Al														1*																				
Or		2		13											15*																			
Wa																•																		
B																	•																	
Ob									1									1*																
Hi																			•															
Ta																				2*														
Dg																					•													
Sa																						•												
Bu																							•											
Sy																								•										
Aw																									•									
Ch																										•								
WF																											2*							
T																												•						
Md							2																						20*					
Pn																														•				
Fi																															•			
Mi																																9*		
Po																																	1*	
Ma																																		5

Chart B-2/Absolute Frequency Association; County — Brant; Township — Onondago; Surveyor — J. Kirkpatrick, 1842

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Ma
Mh	227*	192		56			1	103	132									4	2									5					
Be	2	4*		3				2	4																								
C			•																														
Pw	55	50		82*				10	15									2	1						2			3					
Ce						•																											
Ab						61*						40		1				1															
E							•																										
Bd								2*																									
Ow	4	1		3					5*																								
W										•																							
Ha											•																						
Ms						2	1					4*		1																			
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Sa																						•											
Bu																							•										
Sy																								•									
Aw																									•								
Ch																										•							
WF																											•						
T																												7*			1		
Md																													1*				
Pn																														•			
Fi																															•		
Mi	11	9		2	1		2	4	8										1									3			34*		
Ma																																4*	

Chart B-3/Absolute Frequency Association; County — Elgin; Township — Bayham; Surveyor — M. Burwell, 1809-10

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
Mh	27*	12				1	16	18	2				1				2						1		4								
Be	145	254*	34	55		20	41	29	33		1	4	13		8				1						13		3	2					
C	1	2	2*	1																													
Pw	45	91	18	138*				2	9			1	8		3		1		1						2		6	3					
Ce					2*	1							1																				
Ab		1				45*	6	3	1	2	1	7								1			1		1								
E	6	1				2	9*	4																		1							
Bd						1	1	2*																									
Ow	5	6		1					7*				1		2			1															
W										4*																							
Ha											•																						
Ms												•																					
He	2	33	3	21									56*								1	1					6						
Al														3*																			
Or	5	4							3				1		7*				1						3								
Wa	1	1						1	1							1*																	
B		1					1		1			3					3*								1								
Ir																		•															
Hi																			•														
Ta																				•													
Dg																					•												
Sa																						•											
Bu							2																6*	2	1	1							
Sy							1																1	1*									
Aw																								•									
Ch																										•							
WF		2	1	6								1	1							1							26*	16					
T																												•					
Md																													1*				
Pn																														•			
Fi																															•		
Mi																																•	
Po																																	•

Chart B-4/Absolute Frequency Association; County — Haldimand; Township — Walpole; Surveyor — Wm. Hambly, 1795

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
h	•																																
e	7	7*														2																	
			•																														
w				•																													
e					1*																							1					
o						•																											
							•																										
d								•																									
w				7					12*							2										1							
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e				2	2								2*																				
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a							2									3*												3					
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v							2																		2*								
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																																21*	
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Chart B-5/Absolute Frequency Association; County — Haldimand; Township — Rainham; Surveyor — Wm. Hambly, 1795

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
Mh	1*	1					1	1																	1							
Be	7	7*							3																							
C			•																												
Pw				•																												
Ce					•																											
Ab						•																										
E							•																									
Bd								4*																								
Ow									5*																							
W										•																						
Ha											•																					
Ms												•																				
He													2*																			
Al														•																		
Or															•																	
Wa																5*																
B																	•															
Ir																		•														
Hi																			•													
Ta																				•												
Dg																					•											
Sa																						•										
Bu																							•									
Sy																								•								
Aw							1																		1*							
Ch																										•						
WF																											1*					
T																												1*				
Md																													•			
Pn																														•		
Fi																															•	
Mi									3							10															19*	
Po																																•

Chart B-6/Absolute Frequency Association; County — Norfolk; Township — Charlotteville; Surveyor — W. Hambly, 1795

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
Mh	*																																
Be		*																															
C			1*																														
Pw	1			1*																													
Ce					*																												
Ab						*																											
E							*																										
Bd								*																									
Ow			1	4					23*							1																	
W										*																							
Ha											*																						
Ms												*																					
He													*																				
Al														*																			
Or															*																		
Wa																*																	
B																	*																
Ir																		*															
Hi																			*														
Ta																				2*													
Dg																					*												
Sa																						*											
Bu																							*										
Sy																								*									
Aw																									1*								
Ch																										*							
WF																											*						
T																												1*					
Md																													*				
Pn																														*			
Fi																															*		
Mi																																7*	
Po																																	1*

Chart B-7/Absolute Frequency Association; County — Norfolk; Township — Windham; Surveyor — Wm. Hambly, 1797

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
Mh	13*	4		1			1	4	2																								
Be	20	26*	1	3																													
C			15*	4					1														3		1								
Pw	2	1	4	55*					14														2				1						
Ce					6*																												
Ab					1	5*														1					2								
E							4*																1		1	1							
Bd	1	1					5	6*																									
Ow	1		3	16			1	1	54*							1				1										25		2
W										•																							
Ha											•																						
Ms												•																					
He													•																				
Al														•																			
Or															•																		
Wa				1												1*																	
B																	•																
Ir																		•															
Hi																			•														
Ta																				6*													
Dg																					•												
Sa																						•											
Bu																							•										
Sy																								•									
Aw	2	2		1			1	3																	13*								
Ch																										•							
WF																											•						
T																												2*					
Md																													•				
Pn																														•			
Fi																															3*		
Mi																																2*	
Po									1																								2*

Chart B-8/Absolute Frequency Association; County — Norfolk; Township — Woodhouse; Surveyor — Wm. Hambly, 1795

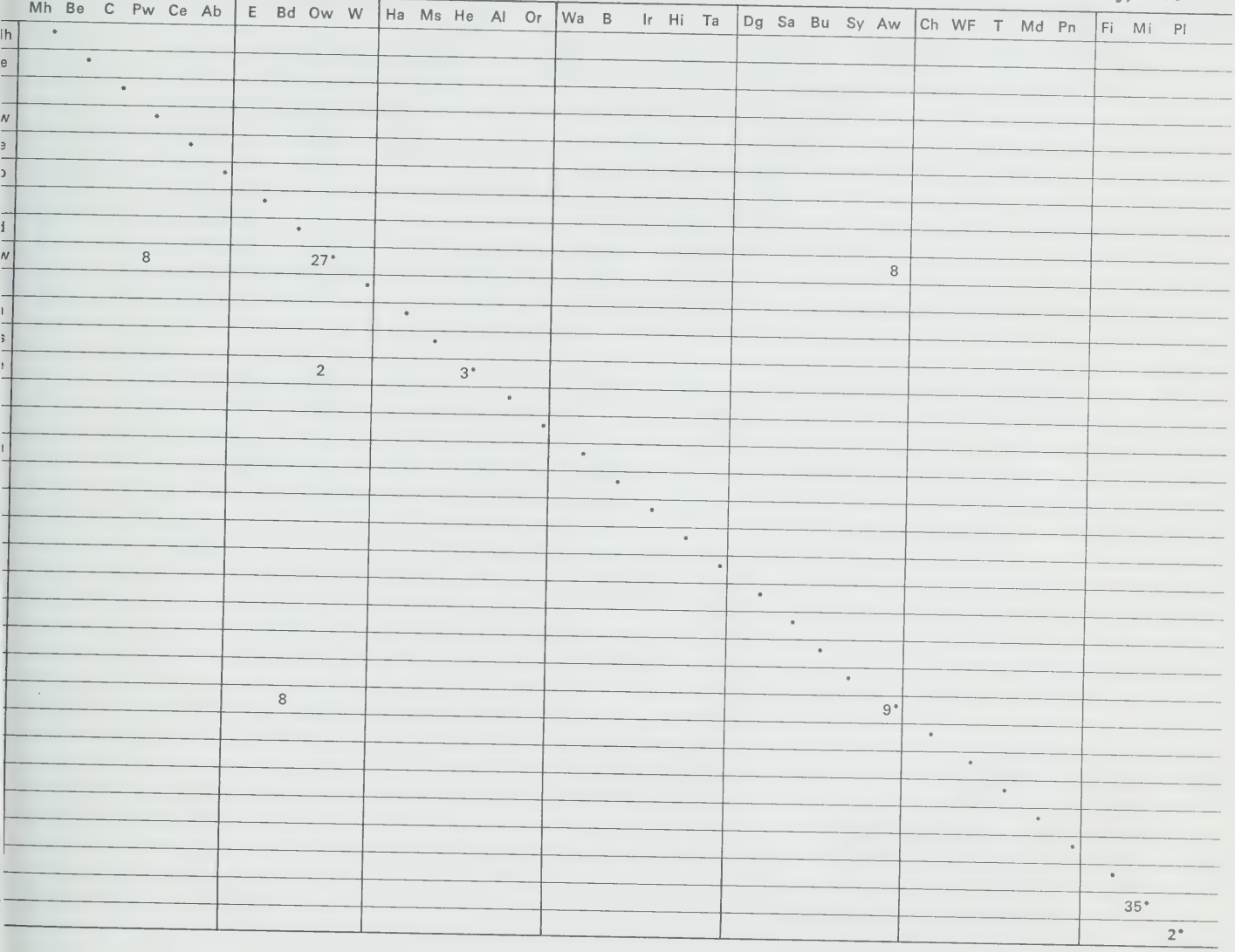

Chart B-9/Absolute Frequency Association; County — Norfolk; Township Walpole-Woodhouse Boundary; Surveyor — M. Walsh, 1846

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ir	Hi	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
Mh	1•																																
Be	4	7•		4		1			3				3												1								
C			•																													
Pw				•																												
Ce					•																											
Ab	1	3				3•			2				3																			
E							•																									
Bd								1•																								
Ow									•																							
W										•																						
Ha											•																					
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He				2					2				2•																			
Al														•																		
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Fi																															•	
Mi																																•
Po																																

Chart B-10/Absolute Frequency Association; County — Norfolk; Township — Walsingham; Surveyor — Wm. Hambly, 1795

	Mh	Be	C	Pw	Ce	Ab	E	Bd	Ow	W	Ha	Ms	He	Al	Or	Wa	B	Ma	Hu	Ta	Dg	Sa	Bu	Sy	Aw	Ch	WF	T	Md	Pn	Fi	Mi	Po
Mh	3*			2																													
Be	10	11*					1																										
C			•																														
Pw	1	1	3	24*								2	1		10																		
Ce					•																												
Ab						•																											
E							1*																1										
Bd								•																									
Ow									2*																								
W										•																							
Ha											•																						
Ms												•																					
He				2									4*		1																		
Al														•																			
Or	1	1	4	8			1								25*	1							1		1						1		
Wa																3*																	
B																	•																
Ma																		1*															
Hu																			1*														
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Dg																					•												
Sa																						•											
Bu																							1*										
Sy																								•									
Aw																									8*								
Ch																										•							
WF																											1*						
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Pn																														•			
Fi																															•		
Mi																																40*	
Po																																	•

Soil Capability Classification Canada Land Inventory

This capability classification is one of a number of interpretive groupings for agricultural or other purposes that may be made from soil survey data. In this classification the mineral soils are grouped into seven classes on the basis of their suitability and limitations for agricultural use. Classes 1, 2 and 3 are considered suitable for sustained production of common field crops, Class 4 is physically marginal for sustained arable agriculture, the Class 5 is capable of use only for permanent pasture and hay, Class 6 is capable of use only for wild pasture. While the soil areas in Classes 1 to 4 are suited for cultivated crops they are also suited for permanent pasture. Soil areas in all classes may be suited for forestry, wildlife, and recreational uses. For the purposes of this classification trees, tree fruits, cranberries, blueberries and ornamental plants requiring little or no cultivation are not considered as cultivate or common field crops.

This capability classification will be applied to virgin as well as to presently cultivated lands. The classification may appear to be relatively simple but the problems which will arise in placing soils in the most appropriate class are complex. While not in itself a guide to the most profitable use of land, it should be a good inventory of our agricultural soil resources and, therefore, be a guide to better land use in Canada.

Assumptions

This soil capability classification is based on certain assumptions which must be understood by those applying this interpretive classification, if the soils are to be assigned consistently into the various classes. Those using the soil capability maps and statistical data also must understand the assumptions if they are to derive full benefit from such information and avoid making erroneous deductions. These assumptions are

1) The soil capability classification is an interpretive classification based on the effects of combinations of climate and soil characteristics, on limitations in the use for agriculture, and on risks of soil damage and general productive capacity for common field crops. Shrubs, trees or stumps are not considered as limitations to use unless it is entirely unfeasible to remove them.[1]

2) Good soil management practices that are feasible and practical under a largely mechanized system of agriculture are assumed.

3) The soils within a capability class are similar only with respect to degree, and not to kind, of limitations in soil use for agricultural purposes or hazard to the soil when it is so used. Each class includes many kinds of soil and many of the soils within any one class require unlike management and treatment. The subclass provides information on the kind of limitation. Capability Class 1 has no subclasses. Information for specific soils is included in soil survey reports and in other sources of information.

4) Soils considered feasible for improvements by draining, irrigating, removing stones, altering soil structure, or protecting from overflow, are classified according to their continuing limitations or hazards in use after the improvements have been made. The term "feasible" implies that it is within present-day economic possibility for the farmer to make such improvements and that a major reclamation project is not required. Where such major projects have been installed, the soils are grouped according to the soil and climatic limitations or risks that continue to exist. A general guide to what is considered a major reclamation project is that such projects require cooperative action among farmers or between farmers and governments. (Minor dams, small dykes, or field conservation measures are not included.)

5) The capability classification of the soils in an area may be changed when major reclamation works are installed that permanently change the limitations in use or reduce the hazards of risks of soil or crop damage for long periods of time.

6) Distance to market, kind of roads, location, size of farms, characteristics of land-ownership and cultural patterns, and the skill or resources of individual operators are not criteria for capability groupings.

7) Capability groupings are subject to change as new information about the behavior and responses of the soils becomes available.

8) Research data, recorded observations and experience are used as the basis for placing soils in capability classes and subclasses. In areas where such information is lacking, soils are placed in capability classes and subclasses by interpretation of soil characteristics in accord with experience gained on similar soils elsewhere.

9) The level of generalization of the soil capability classification is indicated by the scale on which the information is published.

Soil Capability Classification for Agriculture

Class 1/Soils in this class have no significant limitations that restrict their use for crops.

Class 1 soils have level or gently sloping topography, they are deep, well to moderately drained and have good water-holding capacity. These soils are naturally well supplied with plant nutrients. They are easily maintained in good tilth and fertility, and erosion hazard (wind and water) is low. They are moderately high to high in productivity for a wide range of field crops.

Class 2/Soils in this class have moderate limitations that reduce the crops or require moderate conservation practices.

Class 2 soils require careful soil management including conservation practices to prevent soil deterioration o to improve air and water relations when the soils are cultivated. The limitations are not severe and the practices are easy to apply. Moderate limitations singly, or in combination, may include the effects: 1) topography; 2) slight to moderate damage from erosion; 3) somewhat less than ideal soil depth; 4) some difficulty in tillage owing to soil structure or stoniness; 5) wetness correctable by drainage but existing permanently as a moderate limitation; 6) occasional damaging overflow; 7) slow permeability of the subsoil; 8) moderate climatic limitations on soil management and use.

Soils in this class have good water

holding capacity and are either well supplied with plant nutrients or highly responsive to inputs of fertilizer. They are moderately high to high in productivity for a fairly wide range of crops.

Class 3/Soils in this class have severe limitations that reduce the choice of crops or require special conservation practices.
Class 3 soils have more severe restrictions than those in Class 2 and conservation practices are usually more difficult to apply and maintain. Limitations adversely affect the timing and ease of tillage, planting and harvesting; the choice of crops; the application of conservation practices; or some combination of these limitations. The limitations may result from: 1) moderately rough topography; 2) moderate damage from erosion; 3) less than ideal soil depth; 4) difficulty in tillage owing to soil structure or stoniness; 5) wetness or continued water-logging after drainage; 6) frequent overflow accompanied by crop damage; 7) moderately low water-holding capacity; 8) transitory moderate salinity; 9) very slow permeability of the subsoil; 10) moderate fertility status and not highly responsive to inputs of fertilizer; 11) moderately severe climatic limitations on soil management and use.

Class 3 soils are medium to moderately high in productivity for a range of crops.

Class 4/Soils in this class have severe limitations that restrict the choice of crops. They require special conservation practices and very careful management, or both.
Class 4 soils have such limitations that they are suited only for a few crops, or the yield for a range of crops may be low, or the risk of crop failure may be high. Limitations may result from 1) rough topography or steep slopes; 2) severe damage from erosion; 3) shallow soils; 4) serious difficulty in tillage owing to soil structure or stoniness; 5) excessive wetness with continued hazard of water-logging after drainage; 6) frequent overflows accompanied by severe crop damage; 7) low water-holding capacity, 8) moderate salinity; 9) low fertility not easily corrected; 10) severe climatic limitations on soil management and use.

Class 4 soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a special crop.

Class 5/Soils in this class are unsuited for cultivated field crops except perennial forage crops but are responsive to improvement practices.
Class 5 soils have such serious soil, climatic or other limitations as to make them unsuited for the production of field crops. They are suited, however, to the production of adapted grasses and legumes which may be established or improved through the use of farm machinery. Such improvement practices may include cultivation, seeding, liming, fertilizing and water control.

Class 6/Soils in this class are unsuited to cultivation but are capable of use for unimproved permanent pasture.
Class 6 soils have some natural sustained grazing capacity for farm animals but have such serious soil, climatic, or other limitations as to make impractical the application of improvement practices which can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery to improve them, or because the soils are not responsive to improvement practices, or because of a short grazing season, or because stock watering facilities are inadequate. Where costly clearing is required to change Class 7 areas to Class 6 areas, those areas shall remain classified as Class 7. Such improvement practices as may be affected by seeding and fertilizing by hand or by aerial methods shall not change the classification of these soil areas.

Class 7/Lands unsuited for agriculture.
The soil areas in this class have very serious climatic or soil limitations that prevent their use for cultivated crops or improved permanent pasture and are not naturally suited for unimproved permanent pasture. All land areas not included in Classes 1 to 6 shall be placed in this class. Hence this class will include productive forest land, wasteland, bodies of water too small to delineate on maps, townsites, parks, airports, railroads, and roads. Lands used by the agricultural industry that are not in themselves productive for agricultural crops shall nevertheless be placed in this class.

Organic Soils
This interpretive soil capability classification will not be applied to unimproved or virgin organic soil as criteria are lacking in Canada to make such interpretive judgments. Unimproved or virgin organic soils, however, are an important component of the landscape in many of the agricultural areas of Canada. The work planning conference decided that unimproved or virgin organic soils should be designated by the letter O.

Improved organic soils used for agriculture shall be classified at the class level only in Classes 2 to 5 inclusive, and shall be designated by the letter O followed by the class designation as a suffix.

The definition of organic soils is that decided on by the National Soil Survey Committee (NSSC) which reads as follows: "Soils that contain 30 percent or more of organic matter and have a depth of 12 inches or more of consolidated organic material."

Soil Capability Subclasses
Subclasses are divisions within classes that have the same kind of dominant limitations for agricultural use as a result of soil and climate. To date 12 different kinds of limitations have been recognized at the subclass level. They are climate (c); structure and permeability (d); erosion (e); nutrient deficiencies (f); overflow (i); soil moisture deficiences (m); salinity (n); stoniness (p); lack of depth of soil (r); adverse inherent soil characters (s); topography, slope or pattern (t); excess water other than due to overflow (w).

Guidelines for Placing Soils in Capability Classes[2]

Subclass c
Soils where the climate (temperature, frostiness, rainfall) is the only major limitation. Hazards of damage by hail, hurricanes, rain, snow, and winds are not included. This subclass denotes a significant adverse departure from what is considered the median climate of the region in which this comparative capability classification applies. Subclass c may be used either on a subregional or local basis.

The soils placed in this subclass because of adverse subregional climate will be the highest class soils of the subregion as they have no other limitation. Soils with other significant limitations or hazards to use will be placed in lower classes as the subregional climate will adversely affect all of them. Locally, frostiness will be the chief climatic factor in placing soils in this subclass. The evaluation of local adverse temperature effects on class designation must be based on both intensity and frequency.

The median climate may be broadly defined as one with sufficiently high growing season temperatures to bring field crops to maturity in a frost-free period exceeding 90 days and with sufficient precipitation to permit crops to be grown each year on the same land without a high risk of crop failure. Precise guidelines in regard to significant departures from the median as they affect the class designations were not established by the work planning meeting, as in view of the studies now under way it was decided to postpone such action. As general subregional guidelines, however, the following divisions were made.

Prairie Provinces
Median climate — most of the Black and Dark Grey soil zones.
Brown soil zone: Generally highest Class 3c.
Dark Brown soil zone: Generally highest Class 2c.
Southern Grey Wooded soil zone below 3000 ft. 2c.
(Owing to other limitations Grey Wooded soils will rarely be placed higher than Class 3.)

Eastern Canada
Median climate — the Great Lakes and St. Lawrence Lowlands physiographic region, the St. John River valley, Annapolis Valley, Prince Edward Island. Other parts of the Atlantic provinces may also be considered as having a median climate. There are a number of areas having an adverse significant departure from the median climate but no decision has been made yet regarding the degree of their climatic limitations.

We would like to submit for consideration that the restrictions of this subclass to soils which have no limitations or hazards except climate should apply only on a subregional[3] basis. In the case of local adverse climate, we would suggest that this subclass could be used with other limitations. Under the existing convention there is no way to indicate local frosty areas that have some other limitations. This does not hold for subregional climates that differ from the median climate as these subregions can be defined. The chairman of the meeting would like to have your views on this suggestion.

Subclass d
Soils adversely affected by soil structure and/or permeability. No guidelines were established for class designations.

Subclass e
Soils where actual damage from erosion is a limitation to agricultural use. Damage is to be assessed on the loss in productivity and/or the difficulties in farming the affected soil areas imposed by gullies. No attempt was made to develop specific guidelines for class designations.

Subclass f
Soils having naturally low fertility that either is correctable with constant and careful management in the use of fertilizers and amendments, or is difficult to correct in a feasible way. The limitations may be due to lack of available nutrients, high acidity or alkalinity, high levels of calcium carbonate, toxic elements, inadequate cation exchange capacity, high fixation of plant nutrients.

The following guidelines are suggested for class designations:
Class 2: Soils highly responsive to fertilizers and amendments.
Class 3: Soils only moderately responsive to fertilizers and amendments.
Class 4: Soils in which the low fertility status cannot be improved with feasible management practices.
Class 7: Soils containing toxic elements to vegetation, or plants poisonous to farm animals, which cannot be removed with feasible management practices.

Subclass i
Soils subjected to inundation by streams or lakes.

The following limits were adopted subject to regional interpretation.
Class 2i: Occasional damaging overflow.
Class 3i: Frequent overflow with some crop damage.
Class 4i: Frequent overflow with severe crop damage including some years without a crop.
Class 5i: Very frequent overflow with effective grazing period longer than ten weeks.
Class 6i: Very frequent overflow with effective grazing period shorter than ten weeks and longer than five weeks.
Class 7i: Land inundated for most of the growing period.

Subclass m
A group of soils adversely affected by droughtiness owing to inherent soil characteristics. Usually coarse textured soils with low water holding capacity but may include some fine textured soils with high water holding capacity. Not to be confused with climatic drought.

The following general guidelines were accepted.

This subclass will not be used for Class 2 soils.

As compared to soils under the same climatic conditions which do not have this limitation, the following general rules will apply.
Soils moderately affected by droughtiness — drop one class.
Soils moderately severely affected by droughtiness — drop two classes.
Soils severely affected by droughtiness

— drop three classes.
Soils very severely affected by droughtiness — drop four classes.

Subclass n
Soils adversely affected by the presence of soluble salts. Soils with enough salts to adversely affect crop growth or range of crops which may be grown will not be placed in Classes 1 or 2.
Class 3: Crops moderately affected. (Class 4 in those subregions where top class is 3c.)
Class 4: Crops seriously affected with crop failure in some years.
Class 5: Crops seriously affected on cultivated land with crop failures in most years but salt-tolerant forage crops can be established and maintained.
Class 6: Soils too salty except for native salt-tolerant grasses. If poisonous plants are present place in Class 7.
Class 7: Growth of native useful vegetation impossible.

Evaluation of effect of salinity should be based on its effect over a ten-year period.

Subclass p
Soils sufficiently stony as to significantly increase the difficulty of tillage, planting, and harvesting.

It was agreed the stoniness classes accepted by the NSSC in 1955 and 1963 will be used in establishing capability classes except that stoniness Classes 1 and 2 would not be considered as limitations.
Stoniness 3 — Class 3 or Class 4
Stoniness 4 — Class 4 or Class 5
Stoniness 5 — Class 6 or Class 7

Subclass r
Soils where the rooting zone is restricted by consolidated bedrock.

The effect of consolidated bedrock near the surface on crop production is variable in intensity in different climatic regions. Hence precise guidelines for all of Canada cannot be established. The meeting decided, however, that where depth to bedrock is less than 6 inches the soil will not be rated higher than Class 5, and where depth to bedrock is more than 3 feet the class rating will not be affected except under irrigation.

Subclass s
Soils where the limitations are caused by combinations of adverse inherent soil characteristics rather than single limitations covered by subclasses d, f, m and n. This subclass is used to indicate accumulative effects of two or more of these limitations where each limitation by itself would not affect the class rating.

Subclass t
Soils where the topography (slope and pattern) is a limitation in agricultural use.

The meeting agreed on the following guidelines based on topographic classes and symbols adopted by the NSSC in 1963. In this scheme capital letters are used for multiple slopes (irregular surface).
Class 1 — 0.5% Aa, Bb, C
Class 2t — 2-5% c; 6-9% D
Class 3t — 6-9% d; 10-15% E
Class 4t — 10-15% Ee
Class 5t — 16-30% Ff
Class 6t — 31-60% Gg
Class 7t — 60+% Hh.

Subclass w
Soils where excess water, apart from that brought about by inundation, is a limitation in their use for agriculture. Excess water may be the result of poor soil drainage, high water table, seepage, or runoff from surrounding areas. Usually soils needing drainage have some permanent limitation that precludes placing them in Class 1 even after drainage.

If drainage is considered feasible at the farmer level, wet soils will be classified according to their continuing limitations or hazards after drainage. If drainage cannot be effected without community action then wet soils will be classified on the basis of their present limitations.

Since the problem of classifying wet soils will require regional application of the NSSC Soil Moisture Classes, no national guidelines were proposed. With further study regional guidelines may be developed.

Subclass x
Soils where two or more limitations reduce their use for agriculture. No single limitation is sufficiently severe to change the soil class by itself.

Analysis of Changes

Township changes in this study were analyzed by using a variation of a statistical shift analysis. The shift technique used is based upon the fact that changes in acres grown or number of livestock kept observed between the census years 1961 and 1966 are dependent upon the land use or type of livestock farming carried on in 1961 and by other forces generating the change in the time period considered.

The first phenomenon, the land use and livestock numbers on hand in 1961, provides the agricultural base upon which changes can be made. The actual changes occurring will be weighted by this agricultural base. The technique adjusts the actual change by adjusting for the effect of the agricultural base. The resultant net change or shift within a township, compared with the area change, estimates how the change generated by other forces differs between the township and the whole area. This study used the change occurring between 1961 and 1966 in land use and livestock units kept in the 12 counties of southwestern Ontario bordering Lakes Erie and St. Clair.

The following is a description of the calculation of the actual change and the shift.

E_{ij} = acres of the ith crop or livestock animal units kept and the jth township in the initial time period.

E^*_{ij} = the same in the terminal period.

E_i = acres of the ith crop grown or livestock animal units kept in the area in the initial time period.

E^*_i = acres of the ith crop grown or livestock animal units kept in the area in the terminal time period.

Calculation of Changes

1) Estimating factor each crop or livestock $\left(\frac{E^*_i - E_i + 1.00}{E_i}\right)$

2) Actual area % change $\left(\frac{\Sigma E^*_i - \Sigma E_i \times 100}{\Sigma E_i}\right)$

3) Actual township % change $\left(\frac{\Sigma E^*_{ij} - \Sigma E_{ij} \times 100}{\Sigma E_{ij}}\right)$

4) Estimated township % change

$$\left[\Sigma i \frac{\left(\frac{E^*_i - E_i + 1.00}{E_{ij}}\right) \times E_{ij}}{\Sigma E_{ij}}\right] \times 100$$

5) Actual difference jth township = (3) — (2)
6) Adjustment jth township = (4) — (2)
7) Shift due to economic effects jth township = (5) — (6)

In the analysis, two results are reported. The first is the *actual change* occurring within the township in percentage terms. This is the growth of that group of crops grown or livestock kept within the township during the time period and is estimated by equation 3.

The second is the *shift* occurring. This shift is the change occurring within the township in the time period which is greater or less than the area changes after adjustment for the original township agricultural base. The shift is estimated by calculating changes in the following steps.
a) The difference between actual township and actual area changes is calculated (equation 5).
b) An adjustment is calculated by calculating the difference between estimated township and actual area changes (equation 6). This estimated township change is the area percentage change of each crop grown or livestock units kept weighted by the initial acres or livestock numbers within the township.
c) Deducting the adjustment from the difference.

The resultant shift then indicates the township change which is greater or less than the area average change after township changes resulting from a different agricultural bases are minimized. The shift reported thus indicates growth of the groups of livestock kept or crops grown which are due to effects other than the agricultural base.

Tables 27 and 29 of the 1966 Census of Canada, Agriculture for Ontario, are used to provide the area and township acres of crops and numbers of livestock. The counties used for the area are as follows: Brant, Elgin, Essex, Haldimand, Kent, Lambton, Lincoln, Middlesex, Norfolk, Oxford, Welland, Wentworth.

Crops considered important were as follows: wheat, oats, barley, rye, flax, mixed grain, corn grain, tobacco and other crops. The grain crops are listed in Table 29; tobacco acreage was obtained from a special listing obtained from the census division of DBS; and the acreage for other crops included was obtained by subtracting the acreage of above mentioned crops and the acreage of time hay, corn for ensilage, and oats for fodder from the township acreage of improved land under crops for that township as listed in Table 27 of the Agriculture for Ontario census report.

Table 29 was also used to obtain livestock numbers. Animal unit factors were applied to the reported numbers to make the animal numbers comparable between types. The factors applied were as follows:
1) Dairy herd — milk cows x 1.35
2) Beef herd — total cattle — (milk cows x 1.7) x .6
3) Horses — horses and ponies x 1.0
4) Sheep — sheep x .106
5) Pigs — pigs x .245
6) Poultry — (hens and pullets x .01) + (hens and chickens — hens and pullets x .0042)

These animal unit factors were assumed to be reasonable estimates to use in converting the numbers reported in the census to animal units which report all animals as a unit which is equivalent to a mature milking cow considering the ages and sizes of animals and poultry reported in this table.

The numbers of animal units obtained and acres of crops used in the analysis are reported in Tables 7-6 to 7-10 and C-11 to C-13 along with the calculated changes and shift. These are reported by county and township.

Table C-11/Acres of Feed and Cash Crops, Animal Units of Livestock and Calculated Changes 1961-66 — Brant County.*

Acres feed and cash crops	Acres	Acres	Acres	Acres	Acres
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
Brantford	27,865	36,452	28,200	+30.82%	+29.62%
Burford	26,168	30,095	28,930	+15.00%	+ 4.45%
S. Dumfries	14,628	16,687	13,616	+14.08%	+20.99%
Oakland	4,391	4,878	4,693	+11.09%	+ 4.22%
Onandaga	9,116	9,099	9,097	— .19%	+ .02%
Animal units — Hogs and poultry	Animal units	Animal units	Animal units	Animal units	Animal units
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
Brantford	2,752	3,213	3,271	+16.50%	— 2.10%
Burford	1,651	1,973	1,996	+19.50%	— 1.39%
S. Dumfries	2,219	2,818	2,756	+24.20%	+ 2.79%
Oakland	279	387	337	+38.70%	+17.92%
Onandaga	1,037	1,500	1,262	+44.64%	+22.95%
Animal units — Cattle, horses and sheep					
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
Brantford	9,061	8,442	8,544	— 6.83%	— 1.13%
Burford	6,086	5,468	5,680	—10.15%	3.48%
S. Dumfries	9,560	10,069	9,711	+ 5.32%	+ 3.75%
Oakland	838	512	784	—38.90%	—32.58%
Onondaga	3,282	3,539	3,056	+ 7.83%	+14.71%

*Tables 1 to 10 are included in the text of Chapter 7.

Table C-12/Acres of Feed and Cash Crops, Animal Units of Livestock and Calculated Changes 1961-66 — Norfolk County.

Acres feed and cash crops					
	Acres	Acres	Acres	Acres	Acres
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
Charlotteville	16,849	21,349	18,348	+26.70%	+17.81%
Houghton	11,630	13,728	12,845	+18.03%	+ 7.60%
Middleton	16,387	21,196	17,888	+29.34%	+20.19%
Townsend	26,232	29,955	26,340	+14.19%	+13.78%
Animal units — Hogs and poultry					
	Animal units	Animal units	Animal units	Animal units	Animal units
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
Charlotteville	511	659	611	+28.96%	+ 9.40%
Houghton	347	435	418	+25.36%	+ 4.90%
Middleton	663	1,063	774	+60.33%	+43.59%
Townsend	2,630	2,479	3,155	— 5.74%	—25.70%
Animal units — Cattle, horses and sheep					
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
Charlotteville	1,158	872	1,121	—24.69%	—21.50%
Houghton	1,081	915	1,079	—15.35%	—15.17%
Middleton	1,595	1,676	1,516	+ 5.07%	+10.02%
Townsend	8,184	7,809	7,589	— 4.58%	+ 2.69%
Acres feed and cash crops					
	Acres	Acres	Acres	Acres	Acres
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
N. Walsingham	15,876	21,146	19,108	+33.19%	+12.84%
S. Walsingham	11,839	15,033	13,522	+26.97%	+12.76%
Windham	29,531	36,162	32,123	+22.45%	+13.67%
Woodhouse	10,912	10,914	10,969	+ .02%	— .50%
Animal units — Hogs and poultry					
	Animal units	Animal units	Animal units	Animal units	Animal units
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
N. Walsingham	518	502	609	— 3.08%	—20.64%
S. Walsingham	1,071	1,036	1,252	+ 3.26%	—20.16%
Windham	865	1,247	1,045	+44.16%	+23.36%
Woodhouse	1,205	1,319	1,423	+ 9.46%	— 8.63%
Animal units — Cattle, horses and sheep					
Township	1961	Actual 1966	Estimated 1966	% Change	% Shift
N. Walsingham	1,129	1,159	1,137	+ 2.65%	+ 1.95%
S. Walsingham	1,367	1,073	1,302	—21.50%	—16.75%
Windham	2,970	2,671	2,835	—10.07%	— 5.53%
Woodhouse	3,589	3,758	3,347	+ 4.70%	+11.44%

able C-13/Acres of Feed and Cash Crops, Animal Units of Livestock and Calculated Changes 1961-66 — Haldimand County.

cres feed and
ash crops

	Acres	Acres	Acres	Acres	Acres
ownship	1961	Actual 1966	Estimated 1966	% Change	% Shift
anborough	4,812	4,719	3,848	— 1.93%	+18.10%
. Cayuga	7,897	7,230	5,840	— 8.44%	+17.60%
. Cayuga	2,753	3,135	1,986	+13.87%	+41.73%
unn	3,665	3,242	3,268	+11.54%	— .69%

nimal units —
ogs and poultry

	Animal units	Animal units	Animal units	Animal units	Animal units
ownship	1961	Actual 1966	Estimated 1966	% Change	% Shift
anborough	412	458	500	+ 11.16%	— 10.19%
. Cayuga	729	1,133	881	+ 55.41%	+ 34.56%
Cayuga	303	473	368	+ 56.10%	+ 34.65%
unn	406	1,061	471	+161.33%	+145.33%

nimal units —
attle, horses and sheep

ownship	1961	Actual 1966	Estimated 1966	% Change	% Shift
anborough	2,449	3,038	2,243	+24.05%	+32.76%
Cayuga	4,434	4,591	4,337	+ 3.54%	+ 5.72%
Cayuga	1,742	1,610	1,655	— 7.57%	— 2.58%
unn	1,521	1,263	1,529	—16.96%	—17.48%

res feed and
sh crops

	Acres	Acres	Acres	Acres	Acres
ownship	1961	Actual 1966	Estimated 1966	% Change	% Shift
oulton	6,392	6,560	6,948	+ 2.63%	— 6.04%
neida	10,022	10,537	8,312	+ 5.13%	+22.19%
ainham	8,142	6,995	6,207	—14.08%	+ 9.68%
eneca	11,769	10,519	9,870	—10.62%	+ 5.50%
nerbrooke	1,092	829	1,075	—24.08%	—22.53%
alpole	20,802	18,601	16,467	—10.58%	+10.25%

imal units —
gs and poultry

wnship	Animal units 1961	Animal units Actual 1966	Animal units Estimated 1966	Animal units % Change	Animal units % Shift
oulton	664	1,027	811	+54.66%	+32.53%
neida	1,085	1,539	1,297	+41.84%	+22.31%
inham	760	823	902	+ 8.28%	+10.40%
neca	1,415	1,933	1,715	+36.60%	+15.40%
erbrooke	144	81	175	—43.75%	—65.27%
alpole	2,313	2,776	2,750	+20.01%	+ 1.12%

imal units —
ttle, horses and sheep

wnship	1961	Actual 1966	Estimated 1966	% Change	% Shift
oulton	2,340	2,069	2,176	—11.58%	— 4.58%
neida	5,217	5,421	4,936	+ 3.91%	+ 9.29%
inham	3,563	3,783	3,305	+ 6.17%	+13.41%
neca	5,138	5,076	4,966	— 1.20%	+ 2.14%
erbrooke	404	419	395	+ 3.71%	+ 5.93%
alpole	10,342	10,805	9,768	+ 4.47%	+10.02%

Explanation of Estimates of Gross Farm Income

The estimate of gross farm income from agricultural production for each township in the study was obtained by using the animal unit numbers for each type of livestock and acres of feed and cash crops obtained to estimate sales and value of inventory changes for the 1966 production year. Although the Census of Agriculture reports value of farm products sold, these estimates are for the 1965 production year and they seem to be biased downwards when totals are compared to other estimates of off-farm sales. Since the production data available is for the 1966 year and because of the biases indicated above, it was decided to use the 1966 census data and the 1966 DBS estimates of Aggregate Farm Sales and Inventory Changes for Ontario Agriculture to estimate value added. The final estimates for this year are reported in Tables 2 and 5 of the Agriculture Statistics for Ontario 1968. These estimates are shown in Table 9 under farm cash receipts and inventory adjustments and government payments. The sales and inventory change data were grouped into aggregates to conform to the production classification. The acres and animal units estimated for Ontario were then divided into the estimates of gross farm income from Ontario Agriculture to get estimates of the gross farm income per acre of different crops and per animal unit of different livestock.

Adjustments were made to appropriate categories of production to account for inventory changes and the method of reporting sales. The major adjustment of farm sales was to estimate cattle and calf sales from dairy herds. This estimate was set at $100 cattle and calf sales per milk cow. This was deducted from total cattle and calf sales and added to dairy product sales to obtain total sales from dairy herds. The remainder of the cattle and calf sales was estimated to be returns to beef enterprises. The inventory change was divided up as follows: $23,571,000 to the tobacco crop because this crop is stored and sold in the next calendar year and 1966 was a year of both increased production and price of this crop; the remainder of the inventory change was allocated to the beef and hog enterprises.

Table C-14/Estimated Farm Cash Sales, Ontario 1966, Per Acre and Per Animal Unit.

Crops	Acres	Farm cash receipts $1000	Inventory changes and government payments $1000	Gross value added $1000	Estimated gross value added per acre
Feed grains and flax, oats barley mixed, rye and corn	3,161,642	35,237	—	35,237	$ 11
Wheat	363,153	20,110	—	20,110	55
Tobacco	120,638	113,950	23,571	137,521	1,140
Other crops	800,694	163,328	2,089	165,417	207
Totals	4,446,127	332,625	25,660	358,285	

Livestock	Animal units	Farm cash receipts $1000	Inventory changes and government payments $1000	Gross value added $1000	Estimated gross value added per animal unit
Dairy herd	1,226,745	317,959	22,498	340,457	$ 278
Beef herd	955,326	224,040	10,000	234,040	245
Other rough-age animals	103,532	19,512	168	19,680	190
Hogs	474,222	160,155	5,562	165,717	350
Poultry and Eggs	155,517	160,712	—	160,712	1,033
Totals	2,915,342	882,378	38,228	920,606	

Sources: Census of Canada Tables 29 and 27 for Animals and Acres of Crops, and Agricultural Statistics for Ontario, 1968, Table 2, Farm Cash Receipts from Farming Operators in Ontario 1960-68 adjusted for Inventory Change. Table 5, Income of Farm Operators from Farming Operators, Ontario, 1960-68.

The resultant estimates of gross farm income per acre of crop and animal unit of livestock were then multiplied by the 1966 township acres and animal units to obtain estimates for each township in the study. Tables C-15, C-16 and C-17 show the estimates for the three counties in the study.

The numbers of farm and acreage in farm land were taken from the 1966 census of agriculture. The estimate of gross farm income by non-commercial farms was calculated by using a county estimate of amount of sales from these types of farms of around $1000 and multiplying this constant by the number of non-commercial farms in the township. The resultant total was deducted from the estimated gross farm income for that township to obtain the gross farm income of commercial farms.

able C-15/Estimate of Gross Farm Income from Farm Production in 1966 Brant County.

ownship	Brantford	Burford	S. Dumfries	Oakland	Onondaga
o. of Farms	497	523	290	84	162
o. of Com-ercial farms	322	392	216	68	119
creage in rms (Ac.)	59,005	47,325	37,451	6,751	18,540
alue added ops ($)	5,872,100	9,393,700	442,800	1,546,700	215,800
alue added estock ($)	3,959,000	2,380,700	3,971,200	316,400	1,585,800
alue added tal ($)	9,831,100	11,774,400	4,414,000	1,863,100	1,801,600
otal lue added r acre farms ($)	167	249	118	276	97
timated lue added non-mmercial rms ($)	158,700	118,800	67,100	14,500	39,000
lue added r commer-ıl farm ($)	30,000	29,700	20,100	27,200	14,800

ble C-16/Estimate of Gross Farm Income from Farm Production in 1966 for Norfolk County.

wnship	Charlotteville	Houghton	Middleton	Townsend	N. Walsing-ham	S. Walsing-ham	Windham	Woodhouse
. of farms	398	246	344	651	315	237	554	315
. of Com-rcial farms	314	197	297	404	285	195	452	212
eage in ns (Ac.)	42,255	28,438	40,754	62,168	39,234	27,686	64,239	29,352
ue added ps ($)	10,669,900	6,023,800	8,843,700	9,131,300	10,137,400	4,865,400	14,664,500	2,899,300
ue added stock ($)	567,000	424,900	1,222,900	3,450,700	607,700	854,800	1,468,900	1,774,100
ue added ıl ($)	11,236,900	6,408,800	10,066,600	12,582,000	10,745,100	5,720,200	16,133,400	4,673,400
al value ed per e in ns ($)	266	217	247	202	274	207	251	159
mated ie added ion-mercial ns ($)	68,500	39,900	38,300	201,300	24,400	34,200	83,100	83,900
ie added commer-farm ($)	35,600	32,500	33,800	30,600	37,600	29,200	35,500	21,600

Table C-17/Estimate of Gross Farm Income from Farm Production in 1966 for Haldimand County.

Township	Canborough	N. Cayuga	S. Cayuga	Dunn	Moulton	Oneida	Rainham	Seneca	Sherbrooke	Walpol
No. of farms	144	213	98	92	195	209	202	260	27	48
No. of Commercial farms	75	138	59	62	89	160	135	163	10	33
Acreage in farms (Ac.)	20,659	32,714	12,356	12,418	20,971	34,653	25,210	38,003	4,060	64,83
Value added crops ($)	140,200	164,400	60,100	94,200	270,200	221,100	145,700	173,600	41,600	597,00
Value added livestock ($)	1,036,300	1,681,800	686,700	1,160,900	1,001,700	2,502,600	1,529,200	2,359,200	142,700	4,304,40
Value added total ($)	1,176,500	1,846,200	746,800	1,255,100	1,271,900	2,723,700	1,674,900	2,532,800	184,300	4,901,40
Total value added per acre in farms ($)	57	56	60	101	61	79	66	67	45	7
Estimated value added by non-commercial farms ($)	71,100	77,200	40,200	30,900	109,200	50,500	69,000	99,900	17,500	154,50
Value added per commercial farm ($)	14,700	12,800	12,000	19,700	13,000	16,700	11,900	14,900	16,700	14,10

[1]While present forest cover is not generally considered a factor in this soil capability system it may be used in the placement of soil areas in Class 7 where costly clearing will only result in placing the areas in Class 6.

[2]See also Soil Conservation Service, U.S.D.A. Agricultural Handbook No. 210, pp. 13-18.

[3]Subregional as used here applies to significant divisions of the three regions previously mentioned; namely Eastern Canada, Western Canada except the West Coast, and the East Coast.

Resource Categories

ater Resources
Natural Resources
1 Waterfall
3 Bathing beach
7 Wild rice area
8 Exceptional island
0 Lake
Manmade Resources
9 Swimming facilities
0 Boating facilities and ramp
2 Marina, fuel, supplies
4 Religious camp
6 Campsite
7 Canal
8 Fishway, dam, drainageway
0 Lighthouse
1 Fish hatchery
2 Mill ponds
3 Reservoir
4 Roads

Wetland Resources
Natural Resources
35 Exceptional wetlands (natural water storage areas)
39 Wetland projects, lakeshore erosion control
40 Wildlife preserves
41 Hunting preserves

Topographical and Geological Resources
Natural Resources
45 Exceptional remains
46 Bed rock exposures
47 Fossil exposures
Manmade Resources
59 Trailer camp
60 Picnic area
61 Golf course

Vegetational Resources
Natural Resources
66 Rare remnant
67 Reforestation projects
70 Specimen (tree)
72 Orchard
Manmade Resources
75 Provincial forest, forest station, bird farm
76 County forest
78 Provincial park
79 Conservation authority area

Historical and Cultural Resources
Manmade Resources
81 Bridge
83 Old mill
85 Historical church
87 Historical home
89 Military RCMP
90 Historical land tract
92 Historical marker
93 Museum
94 Restaurant — native dishes
95 Native handicraft
96 Local festivals
97 Fairground, market
99 Power plant
100 Modern mill
101 Industry open to public
102 Commercial fishing
103 Exceptional institution
109 Ethnic community
111 Outstanding building
114 Private land

Wildlife Resources
Natural Resources
156 Wolf
157 Deer
185 Pheasant
197 Duck

Resources Inventory
(Map 12-4)

Water Resources

Natural Resources

Key	Item	Description	Potential
7-1	Wild rice crop	Marshland. Grand River Conservation Authority. Experimental acreage.	Area being commercially developed. Conservation Authority proposes large acreages. Cost may be prohibitive.
1-2	Minor waterfall	Water dropping off rock ledge 6 feet into pool.	Significance not great by itself. Important to total aspect of its location, sound of water falling.
10-3	Levey Lake	Small, undeveloped. Public access for fishing. Weedy edge, spring fed.	Local recreation. Focus for park development on adjacent land.
10-4	Blue Lakes	Two of three private intermittent small lakes. Dense vegetative protection.	Prime summer or country home site. Small acreage or cluster development.
10-5	Mohawk Lake Brantford	Steep drop from park to polluted water. Canoe use only. Wooded on park side, not developed.	Natural swimming facility if not pollute Rezoning on banks for apartments and incorporate into citywide park system. Pedestrian and recreation use.
3-6	Bathing beach Port Burwell	Iroquois Provincial Park. Excellent sand beach. Area of scrub growth and slum cottages between beach and base of cliff. Driftwood on beach.	Clean up scrub and slum area. Capaci of beach could be greatly increased. Parking on CPR yard; remove car parking from beach.
3-7	Bathing beach Port Burwell	Restricted area. Shack development, not even minimal standards. Booth. Heavily used, car parking restricted.	Remove all buildings and organize wit facilities for greater capacity and amenity as part of recreation node on both sides of channel and pier.
3-8	Bathing beach Port Ryerse	Confined area, small public access. Sand beach, no recreation facilities, no restricted use areas. Old cottages crowding beach at base of cliff. Subject to flooding and high water level.	Could double useable beach by remov ing single row of frame cottages. Bette use of area if cars restricted and spac organized.
3-9	Bathing beach Norfolk County Park	Very narrow sand beach. 40-foot flight of steps down cliff. Remains of wharf. Cliff eroding, subject to ice and high water damage.	Expansion of beach by filling and building wall into lake, clean brush from beach.
3-10	Bathing beach Fishers Glen	Secluded entrance, narrow steep road through woods to very small strip of sand beach. 10- 20-foot drop to beach and water. Small outboards in mouth of Fishers Creek.	Because of land formation no expansi possible. High quality area of cottage Steep slopes in heavy woods.
3-11	Bathing beach Sand Hills Park	Narrow sliver of sand at base of Sand Hills, subject to high water and ice damage. Eroding constantly.	Beach ideal in quality but only 15 feet wide, depends on water level. Very unstable and difficult to expand at ba of Sand Hills.

ey	Item	Description	Potential
12	Bathing beach Turkey Point	Public access to high quality sand beaches. Many racks for outboards causing conflict with bathing. No conflict with cars operating on beach. Some weedy areas reduce beach use. Provincial park provides toilets, guard and change houses. A few trees. Beach narrows to east where private property has retained road with boulders.	Organization of space and functions of recreation would make better use of excellent beach. Overcrowded in areas at peak-use times. Razing of old cottages could double use area and reduce high water level problems.
13	Bathing beach Long Point	Longest, best quality sand beach in Study Area. Public access not rigidly controlled. Heavily used restaurants and stores. Remains of sand dunes gives undulation just back of beach. Provincial park has long beach frontage; entire south shore open to pedestrian movement.	Much prime beach and sand recreation area is used by rundown cottages and three-lane highway leading to park. Razing of buildings, allocating use areas and incorporating swamp and abandoned land could allow a major recreation development.
4	Bathing beach Port Dover	Public sand beach. Adjacent areas developed and organized for parking, amusement, commerce, pier and fishing boat channel. Shade trees, benches. Unused land behind beach at base of cliff. Small cottages on bank overlooking beach and lake. Honky-tonk atmosphere encroaching on beach use.	Honky-tonk, commercial facilities and parking need reorganizing to achieve full capability of beach. Pier-approach to beach made through noise and crush of amusement area could be improved. Add beach facilities.
5	Bathing beach Port Maitland	Gravel and sand beach. Restricted area beside channel and pier. No facilities. Private cottages and fenced property prevents movement along length of shore.	Add beach facilities and expand beach area by razing frame cottages and old buildings.
6	Bathing beach Lowbank	Gravel and cobble beach. Narrow strip between road and water. No parking, no facilities. Private cottages line road. Odor from organic accumulation.	No existing area of public beach. Beach development possible where road set back from beach. Water quality not visually appealing.
7	Bathing beach	Restricted public access, privately owned. Sand and gravel beach. Erosion control using boulders on lake side.	No particular potential for expansion. Well kept private beach.
3	Bathing beach near Evans Point	Very small privately developed sand beach. Protected by weirs. Public access from road.	Restricted by road and cottages. Could increase capacity for public use.
Manmade Resources			
1	Old Welland Feeder Canals	Local importance; growth of industry. Last used in 1922, now severely disrupted by roads. Intermittent water with vegetation overgrowing bottom. System of utility poles and roads on each side gives pronounced linear order. Steep sod banks. 20 feet deep near Grand River at Port Maitland.	Old Welland Canal is past restoring for transportation. Feeder canal could become part of a lineal transportation system, means of reaching series of features. Unique transportation attraction with canal ponies and barges.

Key	Item	Description	Potential
34-2	Concrete road Stromness	8 feet wide. Built about 1922. Materials brought by canal. Isolated pieces remain in good repair.	At intersection of canals, tree arcaded road is attractive approach to canal and cheese factory.
30-3	Beacon Light Mowhawk Is.	Flashing beacon, visible from shore for some distance. On rock and generally awash.	
30-4	Lighthouse Port Maitland	Channel marker at mouth of Port Maitland harbor.	
30-5	Lighthouse Long Point	Tall, 80 feet plus. Visible from Port Dover. Accessible by water or land. Most significant in Study Area.	
30-6	Harbor Flasher Port Burwell	At end of pier for fishing boats.	
32-6	Mill Pond and Dam Backus Conservation Area	Mill pond in camping area. Earth dam, submerged stumps. Small ponds, shaped and maintained below mill in picnic area.	Maximum potential as is. Pond providin recreation and power.
32-8	Vivian Pond and Dam	Large pond formed by earth dam. Cedar swamp edge. Private access. Fishing.	Clean out stumps. Fishing, swimming and limited boating. Edge suitable for picnic and camping. Could be part of node of development with South Grant Park and Mill.
32-9	Smith Mill Pond and Dam	Small lake. Public access. Crops on edges, bank erosion. Small motor boats, swimming. Not developed. Subject to siltation and fertilizer pollution.	Lacks amenities of beach and trees; no feature beside water. Local use.
32-10	Quance Mill Pond and Dam Delhi	Deteriorating facilities. Concrete dam, fishing. Old bridge access.	High potential. Quiet, secluded, intricate channels and ponds. Area suited f passive recreation.
28-12	3 dams on Grand River Brantford	Various sizes and conditions. Of local materials.	Runoff control.
28-13	Dam on Grand River Brantford	Concrete dam in urban area. No access at dam sides, bypass canal filled in.	Retains water levels in river through city. Prevents navigation.
28-14	Lehman Dam and fish ladder Delhi	Recent dam, water reservoir and fish ladder. Conservation area. Prime residential lots on rim edge. Wooded banks.	Inner-city park. Part of green link of river lands through urban area.
28-15	Otterville Dam	Impounded water becomes town park focus. Prime residential sites.	Urban focus, central park and river-land feature. System of pedestrian movement.

Key	Item	Description	Potential
32-16	Mill Pond and Dam	Active renovated mill. Storage silos, water power, dam in good repair. Large weedy pond. No public access. Mill not significant.	Park and residential development focus.
19-17	Swimming pool Paris	Large attractive pool and separate wading pool in town park. Part of variable recreation facilities.	
19-18	Swimming pool Brantford	Large adult pool located several blocks from wading pool in park. Unattractive setting, no amenities, trees or shade.	Adult pool should have been in park where track and ball facilities are; families have to go two places for all to swim.
9-19	Swimming pool Otterville	Adult pool and wading pool in town park.	
9-20	Swimming pool Tillsonburg	Adult pool in town park.	
0-21	Boating facilities Grand River	Minimal ramp into Grand River. Small outboards. Private operation.	Water depth and area restrictive. Potential for better facilities.
6-22	Campsite Brantford Park	Small number of trailer campers. In trees at edge of park in city.	Not to be encouraged in city park.
4-23	Religious Camp, Five Oaks Paris	Picturesque farmstead on bank of Grand River.	Could be expanded for camp type activity for all ages.
4-24	Religious settlement Paris	Private colony of 100 plus cabins. Neat, orderly arrangement in rows on Grand River bank.	Population density appears to be high at present. Restricted area.
-25	Fish hatchery Normandale		Feature of general interest; of regional significance as supplier of fingerlings.
-26	Marina Woodlawn Park	Small fueling and docking facility for small outboards. Very protected up mouth of Sandusk Creek.	Could be operated with Selkirk Park. Swamp area may be of value.
-27	Marina Turkey Point	Large-scale marina; repair, storage, fuel and sales, at west tip.	Marina isolated from other land use. Not objectionable but cramped for space.
-28	Marina Port Rowan	Sheds for storage, fueling and dock facilities. Protected in inner bay.	In critical location; overlooked from highway and town of Port Rowan. Expansion inevitable with no physical problems of access.
-29	Marina Booth's Harbour	Largest marina facility in Study Area. Sheds, lagoons and docking. Overlooked by clifftop cottages. Trailer park crowded about marina.	Expansion to west underway. Dramatic approach up face of cliff. Replace trailers with more boat-oriented facilities.

Key	Item	Description	Potential
20-30	Boat ramp Port Burwell	Water level 2 feet below grade allowing easy launching of small craft.	
19-31	Swimming facilities Colles Lake	Large pond. Surface run-off and spring fed. Privately developed, tables, camping, sand beach, store. Well maintained, toilets, change houses.	Water body not capable of much expansion of facilities. Camping could be expanded. No other similar facilities in the area.
26-32	Campsite Colles Lake	Wooded area on edge of water.	Could be enlarged.
19-33	Swimming Smith Mill	Public access to water body. No facilities or development. Farmed to the edge with few trees.	Locally used. Surface runoff encourages fertilizer pollution. Not particularly attractive.
23-34	Religious Camp Maple Grove	Crystal Springs Park. Abandoned water-filled gravel quarry. Clubhouse and 24 cabins, swimming facilities. Wooded banks, open upper lands.	Excellent example of quarry re-use. Many abandoned pits with equal potential.
22-35	Hooton Lake Osborn Corners	Small private lake. Farming to edge of water. Marine sales and small outboards, swimming. Impounded Blue Creek.	Excellent access to Highway 24, close to Brantford. Could be developed for varied recreation. Run-off pollution problems likely.
26-36 19-37	Ontario Park Osborn Corners	Impounded upper Fairchild Creek. Motel, camping, swimming, exotic animals, pavilion.	Diverse facilities. Not near maximum potential; expansion possible with upgrading of facilities and increased capacity.
20-38	Boat Ramp Grand River	Natural boat ramp area on bank of Grand. Small outboard craft. No facilities.	Use minimal. Off main road. Demand does not indicate immediate development.
20-39	Boat Ramp Grand River	Privately developed, minimal for small outboards. Mowed grass area, tables. Direct highway access.	Space restricted between road and Grand River. Facilities might better be combined where space available.
20-40	Boat Ramp Byng Island	Simple asphalt slip into Grand River. Byng Island Conservation Area. Small outboard craft.	Used by park users. Demand low; adequate facility as is.
19-41	Swimming facilities Byng Island	Two-acre bituminous bottom.	Good model for public pools. More trees would add to amenity.
26-42	Campsites Byng Island	Tent and trailer camping. All facilities. Generally wooded. Crowded at peak season.	Room for expansion and still maintain natural setting. Demand presently high.
28-43	Dams Byng Island	Two existing dams in good repair. Points of attraction for viewing. Combined with bridges. Fishing.	Maintenance critical to water levels in conservation area and Grand River.

Key	Item	Description	Potential
3-44	Reservoir Dunnville		
0-45	Boating facilities Port Dover	Active fishing harbor. Cranes for handling large and small boats, repair and maintenance.	Large capacity and range of craft can be handled. Facilities could be specialized for pleasure and commercial demand.
8-46	Dam Port Dover		
8-47	Dam Caledonia	Concrete dam, major element in water level control on the Grand River. No longer used for water power.	Restrict boating activity on Grand River. Has historical importance to local industry.
9-48	Swimming facilities	Only spring-fed lake in county. Privately owned and developed. Booths, shelter, camping, picnic tables, swimming, stocked lake.	Surrounding acreage bordering water not used; could become major inland recreation node.
5-49	Campsites	No specific land use or organization. Capacity still small due to limited private funds.	Much acreage, open and bush available for campsites and recreational facilities.

etland Resources

Natural Resources

ey	Item	Description	Potential
-1 -1	Turkey Point Company Marsh	Large privately owned marsh. Duck hunting. Canals let fresh water into marsh-bound ponds and provide access for feeding and shooting ducks.	Increased duck population and hunting.
-2	Turkey Point Company Turkey Point	±3000 acres privately owned marsh. Duck, pheasant, rabbit hunting.	Under-used in relation to size of duck population. Private use preserves ducks.
-3 -3	Long Point Company Long Point	+5000 acres. Sand dunes, marsh and beach. Deer and duck hunting. Wind and water erosion of mobile sand. Over-browsing prevents regrowth of tree cover.	Population of deer should be reduced. Fragile landscape should become a wilderness preserve.
4	Oakland Swamp	Extensive acreage. Natural water-holding and stream source areas.	Conserve as natural water-holding and stream source area.
5	Burford Swamp	Natural water-holding, drainage area and stream source.	Conserve from alteration of natural functions.
6	Amphibious animal preserve	Sign on road. Marsh area.	Scientific research and for zoo.

Key	Item	Description	Potential
35-7	Swamp Woodstock (Not in Study Area)	Exceptional wetland. Not in Haldimand-Norfolk Study Area. Large acreage. Influences water runoff, water level and stream sources. Natural water storage area. Swamp and poorly drained soil. Series of ponds, lakes, and bush cover.	Natural capacity for water storage and control; must be conserved against clearing and development. Important for natural drainage, surface runoff, source area for rivers. Potential for nature conservation and recreational use of water bodies and waste land.
35-8	Natural water storage area	Large area of forest. Very flat. Between Venison and Big Creeks in sparsely settled area.	Significant because of size and location. Close to Dofasco and future residential growth. Prevent filling, development and any reduction in capacity.
35-9	Natural water storage area	One of natural features making up an important and complex chain from Lake Erie to Burford.	Part of a natural corridor.
35-10	Natural water storage area	Area very flat. Source area for Big Creek and Young Creek.	Important as source area.
35-11	Natural water storage area	Extremely flat area. Generally more area left in forest cover than usual.	Source area for several small creeks, Brandy, Kent, Trout and Patterson.
35-12	Natural water storage area	Low, marshy area at base of moraine ridge.	Source area for Nanticoke and Patterson Creeks.
35-13	Natural water storage area	Low, flat area between moraine ridge and Big Creek.	Source area for Nanticoke and Big Creeks.
35-14	Natural water storage area	Extremely flat, heavily wooded area.	Source for South Otter and Clear Creeks.
45-15	Wildlife preserve Tanquanyah	In same area as Dry Lake. Tributary area for Grand River. Conservation authority area, duck feeding.	Contiguous with Dry Lake, therefore both can be combined as preserve and wetland.
40-16	Dry Lake	Swamp and standing water. Wetland bush, dead elms. Being used as a garbage fill area.	Duck and bird breeding area. Filling and desecration should be halted immediately.
39-17	Shore erosion control	Boulders dumped along the shore. 4-foot drop to the water.	Method common where problem is minor; can be undertaken by landowners.
39-18	Shore erosion control	Concrete weirs, 20 feet long and 2 feet wide, off shore.	Protect beach and roadbed from high water. Traps sand.
40-19	Wildlife preserve — wildfowl management	Marsh area of Turkey Point.	Could provide observation of water fowl.
35-20	Exceptional wetland	Natural drainage area, marshy, flat and low. Spillway between mounds of moraines.	Source for Reynolds and Spittler Creeks. Conservation of vegetation and water level.

Key	Item	Description	Potential
39-21	Wetland project New Durham	Clearing, draining and stripping organic soil.	Possible sale of soil; destroys natural water drainage and storage.
35-23	Exceptional	Large swamp acreage. Heavily forested, natural drainage and water storage area for Welland and Oswego Rivers.	Important to regional and local water levels. Control of runoff, natural water supply area.
40-24	Norfolk Bird Sanctuary	Game fowl raised.	Important for future increase in shooting.

Topographical and Geological Resources

Natural Resources

Key	Item	Description	Potential
47-1	Fossiliferous rock Windham	Proliferation of fossils in shale beach rock. Accessible.	Not of rare variety. Interest to children and as souvenirs.
45-2	Sand Hills	Unique feature. ±150 feet above water. Privately developed park, narrow beach at base of hill. Over-use is eroding sand and lowering hill.	Regional phenomenon. Tourist and recreation potential. Will deteriorate at present over-use.
46-1	Bedrock exposure Stoney Creek	River bed with 3-10-foot-high rock banks.	Local, isolated instance.
46-4	Bedrock exposure Dry Creek	River bed. Dramatic cut. Soil cover ±2 feet in area.	Local situation.
46-5	Bedrock beach	Gentle slope to deeper water, local condition.	
55-6	Gravel excavations Paris	Extensive pits. 100+ acres, active and abandoned. 40 feet+ deep. Some are water filled. Restrict residential growth to east and west. Storage and buildings dominate skyline. Economically important to Paris.	Abandoned pits — recreational development. Close to Paris — industrial sites, parks and sports facilities. Shallow enough for variety of uses.
55-7	Gravel excavation Brantford	Extensive. Hundreds of acres. No program to reclaim or use. Out of town, no pressure for land. Massive plants and storage piles. No water or vegetation, dust problem.	System of parks; reforest and use for recreation as city of Brantford expands. Highway 403 cutting through; access for development.

Topographical and Geological Resources

■ *Manmade Resources*

Key	Item	Description	Potential
61-1	Golf courses Brantford	High calibre and intensive use. Interesting topography adjacent to Grand River and quality residential area. Direct link with conservation valley lands.	Preserved as green space and part of recreation system along Grand River for pedestrians.
61-2	Golf Course Paris	Attractive topography. Subdivision pressure.	Preserved as green acreage. Subdivision expansion probable. Suburban park would give access to Grand River and lower Paris for pedestrian park system.
61-3	Golf course Tillsonburg	Bottomland. No urbanizing pressures. Natural topography and vegetation. Located in natural river corridor.	Location prime to west entrance to Tillsonburg. Retain as part of natural approach and river system through entire city for pedestrians.
49-4	Land reclamation Windham	Shallow gravel pit ±15 acres. Topsoil replaced and graded for agricultural use.	Productive land. Removal of unproductive and unsightly area.
49-6	Land demonstration	Erosion control and crop demonstration.	Field demonstration in conservation.
49-7	Valley lands Brantford	Flood plain lands in Grand River valley. Pasture land almost at water level.	Flood plain. Valuable link in comprehensive open space system through city; link to golf courses, recreation.
49-8	Valley lands	Small areas. Isolated pastures.	Flood plain.
60-9	Picinic areas Brantford	In natural setting of city park. Numerous tables and barbecue racks; pavilion, concession.	Well located and used.
60-10	Picnic area Paris	Lions park. Open flood plain, no shade, poorly planned, tables.	Planning required to provide tree planting, more picnic facilities, organization of space.
60-11	Picnic area Grand River	Mowed area between road and Grand River. Private, not developed.	Comprehensive recreational development along Grand River corridor.
60-12	Picnic area Otterville	Tables and concession under mature hemlock in park.	Crowded. More space and picnic facilities needed.
60-13	Picnic area Tillsonburg	In-town park. Tables near water.	More facilities needed.
60-14	Picnic area	DTC maintaining tables, flowers, cairn where road bypass left small area.	
59-15	Trailer camp Booth's Harbour	Small area. Partly filled, subject to high water table problems. High density and lack of organization in siting of trailers. Sewage disposal questionable due to high waters.	Area better suited to expansion of large marina and associated facilities for boating. Could be a major boating facility.

Key	Item	Description	Potential
60-16	Picnic area	Isolated wedge between railroad and road. Some large maples, two tables, trash can.	Many areas with similar potential. Minimal development cost; high return in convenience.
61-17	Golf course Port Rowan	Attractive terrain. 18 holes. Includes Dedrich Creek bottomlands. Very accessible. Miniature golf adjacent.	Located close to prime recreational water. Offers choice of recreation. Might offer greater choice of land-oriented recreation.
59-18	Trailer camp Normandale	Small area.	
69-19	Golf course Turkey point	Attractive. Mature vegetation. Well maintained. Top of bluff but no view over lake. Away from noise of water recreation.	Park-like setting. Away from activity. Potential view, hotel complex with escalator down to water.
59-20	Trailer camp Port Burwell	Cluttered settlement of trailers on bluff edge. View over lake. Many permanent trailers. Bluff erosion. Mediocre adjacent cottage area.	View excellent and unrestricted.
59-21	Trailer camp Port Burwell	Camping area. Private development on bluff. Excellent view.	Overlooks provincial park beach. Views, access and closeness to Dofasco make site critical.
60-22	Picnic area Brantford	In-town park on Grand River. Passive recreation, flower gardens, benches, walking paths.	Location gives park potential of being community asset and meeting place. Local focus. Facilities for night use needed. Part of a more comprehensive green-way system through city.
0-23	Ontario Park Osborne Corner	Recreation center. Natural setting, tables, pavilion, store, other supporting facilities and attractions.	Picnic area can be expanded in its natural setting. Removed from highway noise.
1-24	Golf driving range	Facilities for driving range. Small operation may draw from Brantford.	Expansion may be needed with urbanization. Means of speculative land holding.
0-25	Picnic area Grand River	Road side pull-off with a few tables. No development, no controls. Access to the Grand River.	Expansion not apparent. Off main road.
0-26	Picnic area Simcoe	In-city park. Well maintained. Only designed system of parks through a town in the Study Area. Follows natural drainage course. Lawns, trees, flowers, fountains, lights, water, swans, carillon. Passive recreation only.	A genuine green core, totally public and accessible day and night. Gathering place, definite factor in one's impression of the town.
-27	Golf course Simcoe	Edge of town. Lacking in natural topographic variety.	Open green space. Future recreation use for town.

Key	Item	Description	Potential
60-28	Picnic area Windham	Private property. Irrigation pond in pine grove on Big Creek. Used at random by public. Trash, ashes, footpaths, no facilities. Unexpected in extensive tobacco area.	Very pleasant space to stop, secluded. Open area for parking. Woods to explore. Many spots could be used in a similar manner.
59-29	Trailer camp Little Lake	8 trailer facilities. Area open. Borders on lake. Quiet, off main roads.	Acres of land bordering the lake suitable for trailer camping.
61-30	Golf course Delhi	Access to Highway 3. Edge of town. Naturally wooded low area of stream.	Demand for more golf courses and recreation will require expansion in the immediate vicinity of urban areas.

Vegetational Resources

Natural Resources

Key	Item	Description	Potential
70-1	Sugar maple specimen	Standing alone in tobacco field. Shattered by lightning, little top. 19-foot trunk circumference. Largest specimen in area.	Photographic record. Record age when dead.
66-2	Rare remnant Backus Woods	Large acreage. Not accessible. Conservation authority and Lands and Forests controlled. Variety of mature trees. Large stumps.	Wilderness preserve. Limited access for public observance of nature.
67-3	Reforestation area St. Williams	Large acreage. Mature and seedling plots. Significant contrast to open flat countryside. 4000 acres.	Important as demonstration of value of reforesting for soil stabilization and crop protection. Regional value, local feature of contrast.
67-4	Glennie Reforestation Area		
72-5	Orchard Simcoe	Large fruit growing operation "Norfolk Farms". Hundreds of acres of orchards. Property identified by signs, painted buildings and chain of fruit stands.	Large private fruit operation. Intense use of prime soil and climatic conditions. Should be spared from urban sprawl. Seasonal employment.
70-6	Specimen walnut grove Lyndock	Afforested grove of mature black walnut trees on Big Creek flood plain, beside highway. Area attractive but no use made of grove or river access. Significant grove in area.	Timber potential. Could be picnic site. Should be noted by informative plaque.

Manmade Resources

76-1	County forest Townsend	100 acres	—
76-2	County forest Charlotteville	111 acres	—

Key	Item	Description	Potential
76-3	County forest Charlotteville	100 acres	—
76-4	County forest Charlotteville	200 acres	—
76-5	County forest Charlotteville	100 acres	—
76-6	County forest S. Walsingham	99 acres	—
76-7	County forest S. Walsingham	66.5 acres	—
76-8	County forest N. Walsingham	50 acres	—
76-9	County forest N. Walsingham	100 acres	—
6-10	County forest Charlotteville	100 acres	—
6-11	County forest Charlotteville	50 acres	—
6-12	County forest N. Walsingham	25 acres	—
6-13	County forest Charlotteville	50 acres	—
6-14	County forest Charlotteville	60 acres	—
6-15	County forest S. Walsingham	65.5 acres	—
6-16	County forest S. Walsingham	100 acres	—
6-17	County forest Woodhouse	50 acres	—
6-18	County forest Windham	74 acres	—
6-19	County forest Woodhouse	85 acres	—
6-20	County forest Charlotteville	22 acres	—

Key	Item	Description	Potential
76-21	County forest S. Walsingham	100 acres	—
76-22	County forest S. Walsingham	50 acres	—
76-23	County forest Windham	19.5 acres	—
76-24	County forest S. Walsingham	22.5 acres	—
76-25	County forest Houghton	50 acres	—
76-26	County forest S. Walsingham	10 acres	—
77-27	County forest Woodhouse	35.5 acres	
75-29	Provincial forest station and bird farm Normandale	Predominantly heavily wooded. Adjoins Turkey Point marsh and ties into natural water storage area on Fishers Creek.	Large acreage of natural cover for wildlife preservation. Largest wooded area adjacent to intense recreation development at Turkey Point.
75-30	Provincial forestry station St. Williams	Significant plantings of nature coniferous trees and seedling beds. Dramatic visual contrast of coniferous forest and flat landscape. Forest restricts view and gives closure, scale changes.	General attraction as an educational experience. Major seedling supplier in province. Major link in chain of forests, conservation areas and natural water storage areas from Lake Erie to Burford.
78-31	Long Point Provincial Park Long Point	848 acres. High quality sand beach. Private cottages of generally poor quality. Public beach. Concessions. Major 3-lane road through cottage area. High water table is a problem. Heavily used.	Major recreation development. Critical location for access to Point. Inner bay very protected for craft. Recreation potential can be maximized only if re-organization and new land use is effected.
78-32	Turkey Point Provincial Park and Conservation area Turkey Point	782 acres. Excellent beach. Many cottages and permanent residences. Conflicting land use and organization of space with parking on beach. Severe high-water level problem. Commercial strip. Heavily used. Change rooms, toilets. Long expanse of public access to beach and marina facilities.	Controls on development needed to realize full recreational potential. Part of lakeshore chain of concentrated recreation facilities. Poor quality housing on beach frontage and adjacent uplands provide space for developing into major recreational node. Control of adjacent lands could provide links to nearby features.

Key	Item	Description	Potential
'8-33	Provincial Park Port Burwell	±360 acres. Iroquois Beach. Prime sand beach, not developed. Autos on beach. Scrub land behind beach to bottom of cliff. Low density, low quality cottage development. Harbor channel used for fishing. Fishing boat activity.	Capacity much greater than present. Park cars off the beach; increase recreation facilities; raze cottages. Acreage for major recreation node is available. Could provide needed economic impetus to Port Burwell.
'8-34	Provincial Park Selkirk	160 acres. Recently developed. Except for mature forest area park is open and exposed. Good sand beach, boat ramp, trailer camping. Includes mouth of Sandusk Creek.	Important element of evenly spaced provincial parks on lakeshore. Will mature into more attractive campground. Needs more ambitious planting program. Minimal existing facilities.
8-35	Provincial Park Rock Point	238 acres. Recently developed. Flat, open, bare site but for tree fringe along cliffs-top. Drop of 30 feet to water; access difficult. Shale and sand beach. New entrance proposed, through wooded area; present approach is through dilapidated cottage development.	One of lakeshore parks. Will become more attractive when trees grow. Allows public access to point of land; a prime area for development. Geologic feature of crustaceans in shale.
8-36	Provincial Park James N. Allen	335 acres. At Low Point. Includes 66 acres of water, 15 acres of lowland marsh and red maple and 60 acres of former farmland. Remainder of area in various stages of evolution from hawthorn to pioneer species. Flat topography and 2200 feet lake frontage, mostly sand beach.	Related to lake frontage for intensive recreation activities. Development plans include car camping and day use. An important unit in a system of lakeshore parks.
7-37	County Park Norfolk	Well organized space and land use. Facilities for group sports, pavilion, store. Steep drop to water, difficult access by stairs. Natural setting in woods. Well used and maintained.	Expansion along shore. Appears to be near capacity use.
'-38	County Park Haldimand	Attractive stone architecture and entrance.	
)-39	Conservation Area Waterford	Use of abandoned quarries. Picnicking and swimming, no camping. Close to town. Approach by causeway between quarries. Quarries across from conservation area used for town dump, litter and burning.	Natural feature follows through town. Could be pedestrian cycle trail, green way with development of housing. Inclusion of Waterford Pond, bush and swamp to north could expand capacity for greater recreation use.
-40	Conservation Authority Area	Runoff control dam, swimming, fishing, picnicking and parking. New, not inviting or attractive. Large marsh, bird and duck habitat.	Planting and development needs improvement. Reorganize space to allow view of water. Eliminate walking through ditch.
-41	Conservation Authority Forest	Predominantly forest acreage.	

Key	Item	Description	Potential
76-42	Conservation Authority Forest Harris Floyd Tract	Predominantly forest acreage.	
76-43	Conservation Authority Forest	Predominantly forest acreage	
76-44	Conservation Authority Forest	Predominantly forest acreage	
76-45	Conservation Authority Forest	Predominantly forest acreage	
76-46	Conservation Authority Forest	Predominantly forest acreage	
79-47	Conservation Authority Area	Typical heavily wooded v-shaped valley. Dam and road embankment creating small picturesque lake.	Irrigation source. Runoff control. Recreation facility for swimming, fishing, small craft. Focus for residential development on rim.
79-48	Conservation Authority Area Rowan Mills	Bottomland and steep banks of Big Creek. Undeveloped pasture and crop land.	Banks steep and long enough for tobogganing.
76-49	Conservation Authority Forest Armstrong Tract	Forested. Large acreage of low, wet land.	Natural drainage area; conserve forest cover.
76-50	Conservation Authority Forest	Forested	Natural drainage area; conserve forest cover.
79-51	Conservation Authority Area Abigail Becker	Small clearing in pine afforestation on highway. Picnic tables, toilets.	Examples of minimal development. Many similar groves of pines could provide a place to stop, picnic and rest.
79-52	Conservation Authority Area Port Burwell	Bounded by Big Otter Creek. Subject to flooding. No gate attendant, no washrooms, not well maintained. Boat access to Lake Erie.	Close to town. Adjacent to open land for expansion if area on lake becomes recreation node.
79-53	Conservation Authority Area Norwich		
79-54	Byng Island Conservation Area	320 acres. Open mainland, wooded island. Boat ramp, camping, swimming, concession, nature trail, picnic area, sports field.	Development continuing to accommodate demand.
79-55	Conservation Area Teeterville	Runoff control dam. Weedy pond, polluted in appearance and smell, placid. Attractive area. No development, no facilities.	Potential for recreation use depends on water quality improvement.

Key	Item	Description	Potential
97-56	Conservation Authority Area Port Dover	On Black Creek. Access to Highway 6. Close to Port Dover.	More of Black Creek bottom and rim lands should be controlled. Valuable as town expands. Silver Lake and Black Creek join in town.

Historical and Cultural Resources

Manmade Resources

Key	Item	Description	Potential
11-1	Cheese factory	Two-storey frame, no original equipment. Directly on road bordering feeder canal.	Of local historical significance. Museum, restoration, feature of any future canal use.
11-2	Railroad switch-house	Three storey frame, tall and narrow. Apparently used by T-H & B and Michigan Central Railroads. Located in very flat featureless landscape.	Stopping place for railroad riders. Nucleus for railroad museum.
87-3	Senator McCallum home	Large, 6 chimney, yellow brick. Undergoing unfortunate revision; original character being lost. On canal bank, knoll on edge of estuary of Grand River. Isolated.	Restoration, museum. McCallum family important to development of area. Nodal feature close to others in the area.
83-4	Backus Mill	Three-storey frame. Well restored and preserved; equipment functioning. Open to public.	Tourist attraction, preservation of past.
83-5	Vivian Mill	Three-storey frame. Well preserved equipment. Picturesque, private.	Historic feature, open to public for demonstrations. Develop surrounding site.
83-6	Smith Mill	Three-storey frame. Renovated as active mill. Concrete storage silos, old equipment existing in part.	Restoration. Development of area as conservation area, open to public.
83-7	Quance Mill Delhi	Two-storey frame. Complex of smaller frame buildings, quaintly deteriorating. Wood products mill.	Restoration and repair. Building large enough for hall, diningroom, entertainment, night activity. Close to Highway 3, almost in Delhi. Museum, town-supported center for youth activity.
1-8	Silverwoods Dairy Tillsonburg	Yellow brick, four-storey factory, brick stack building complex. Interesting style. On Highway 3, in flood plain.	Preservation. Large window area may be suitable to some factory use of building. Subject to flooding.
3-9	Otterville Mill	Two-storey frame. Good repair.	Historic building. Conservation museum or town project.
7-10	Fairground Tillsonburg	In town. Permanent structures. Access to impounded water.	Permanent green space as part of pedestrian links through city.

Key	Item	Description	Potential
97-11	Fairground Norwich	Outskirts. Open, one horse barn. Track used all year.	Retain as permanent open space.
97-12	Fairground Paris	Edge of town. Two buildings, track. Surrounded by gravel diggings.	Not attractive site. Retain area for development when pits reclaimed.
97-13	Fairground Burford	On edge of town.	
87-14	Historical home Bell Homestead	Tourist attraction. Well maintained house, small park, concession.	Space restricted. Could add other vintage buildings or attractions, more parking.
87-15	Adelaide Hoodless home	Restored house, neat grounds, adequate parking, plaque.	Space available for other attractions for women; crafts, garden, food, antiques.
97-16	Fairground Ohsweken	On edge of town. White painted grandstand, gates.	Location for ethnic occasions, markets, displays.
92-17	Historical marker	Cairn and small park to Adelaide Hunter Hoodless, founder of Women's Institute.	
111-18	Woolen Mills Paris	Four- or five-storey mills; some renovated and used. Water power, some equipment. Economic significance for historical development of Paris.	Buildings can be used for industry. Preserve and restore for public use. Across from park. Include in Nith River open space system.
111-19	Churches, hotel, homes stores	Churches extremely large. Cobble construction of buildings. Old stores and mills backing on Grand River.	Preservation. Tourist attraction, tours of historical and architectural importance through the town.
111-20	Hotel — new City Hall	Significant buildings, historical and expression of the "new" Brantford.	Comprehensive cataloguing of significant buildings needed. Relation to Indian and white history.
93-21	Museum Bell Telephone Brantford	Unique collection, displayed in restored and preserved homestead.	Tourist attraction in city, not commercialized.
87-22	Home and farm George Brown Brantford	Isolated land in Grand River meander. Private farm and home. Early experimental farming. Plaque.	Prime high density development area for Brantford. Bridges needed. Large scale playing fields, recreation, schools.
83-23	Glass factory ruins Dry Lake	Foundation remains. 100 years old. Overgrown in woods. Used water power. Sandstone deposit used for glass.	Series of old quarries, some with water, could be part of recreation development at Dry Lake.
99-24	Hydro Plant Nanticoke	Mammoth complex of large structures. Large site on Lake Erie shore. Island of concentration in low-intensity area.	Long-reaching visual impact of physical development. Potential as catalyst for regional industrial complex and supporting facilities. Pollution potential high.

ey	Item	Description	Potential
1-25	Hydro Plant Nanticoke	Information office and displays, public relations staff tours. Observation platform.	Tourist attraction for public image.
0-26	ERCO Port Maitland	Phosphate manufacture. Immense buildings, acres of settling beds, at mouth of Grand River. Visual impact for miles.	Pollution problem. Example of structures imposed on landscape with very low visual absorptability. Warning for future lakeshore industrialization.
3-27	Saw mill	Active, using local trees from reforestation thinning. Small operation.	Not common in area; limited resources.
2-28	Historical marker Turkey Point	Site of Fort Norfolk. Cairn.	Potential for reconstruction of fort.
4-29	Private lands Naturalist club	Acreage of posted woods. Adjacent to recommended forest acquisition land.	Means of open space preservation and conservation.
9-30	Transmission towers	Tall, red and white, steel towers in clusters of three. Visible for long distance because topography flat and open.	Questionable whether land with direct visual access to lake should be occupied.
2-32	Commercial fishing Port Burwell	Two or three boats. Facilities deteriorating; appearance of dying business. Conservation authority area adjacent to fishing boat facilities.	Prospect not bright for improvement. Still some feeling of fishing village. Retired boats could do tourist duty, transportation or tours.
1-33	Ethnic community Mennonite	Farm techniques, horse-drawn transportation, dress.	
1-34	Outstanding market tobacco auctions	Large warehouse complex and sales barns. Local significance; seasonal focus for farmers.	Scale and amount of productive land occupied gives examples of impact of industry.
1-35	Industry open to public Canadian Tobacco	Educational visit to vital center of local industry.	Of regional importance; local seasonal focus.
1-36	Ethnic community Mennonite	Farming techniques, horse-drawn transportation, dress.	
1-37	Industry open to public Brantford	Bluebird Bus Factory, occupying old airfield facilities.	Major emp'oyer; expansion expected.
		Massey-Harris Factory. Impressive complex, close to town.	Plant visible from Highway 403. Size of plant and colorful equipment is eye catching. Major employer.
38	Historical marker Paris	Paris Plains School.	

Key	Item	Description	Potential
103-39	Burch Industrial Farm Reformatory	On abandoned airport. Complex of low buildings, attractive grounds, farming acreage.	If acreage is large, being under one ownership would make it attractive for major residential or industrial development or expanded institutional facilities.
109-40	Tuscarora Indian Reserve	Area of identifiable ethnic cultural, economic, educational, social and visual contrast. Predominantly wooded. Low density settlement.	Abundance of land. Extensive Grand River frontage. Essentially undisturbed resource base. Unique cultural heritage and ethnic expression.
92-41	Historical marker Ohsweken	At town hall. Insignificantly displayed, grounds not maintained.	Far greater potential as significant historical event. Opportunity for a "historical park" collection of items and events of Indian folklore and heritage.
95-42	Native handicraft reserve	"Indian Village" restoration, site of annual fair. Crafts for sale. Neglected appearance.	Excellent potential for larger, more diverse and significant restoration and festivals.
87-43 92-44	Historical home Pauline Johnson	Elegant house on Grand River. Tourist facilities. Restored and well maintained. Significant architecture.	Location on Grand River with highway access and ferry crossings make this a natural beginning of a historical tour with various buildings, sites, modes of travel, festivals, foods and entertainment. Educational and historically significant.
99-45	Power transmission towers	Ontario Hydro microwave transmission, under construction. Large facility of 20+ acres.	May be nucleus for other non-agricultural industry. Land cost reasonable; access good; expansion possible.
89-46	RCMP Barracks Ohsweken	Office building and flag. Uncommon in this part of Ontario. Indicates the uniqueness of the Reserve.	Could be an attraction of comprehensive tour of Reserve, including history of RCMP.
96-47	Local Festival Tuscarora Reserve	Annual festival for display and sale of handicrafts; music. Regional attraction.	Potential of much greater attraction combined with variety of games, etc. Longer or seasonal programs.
90-48	Historical Land Tracts Cayuga	Fradenburg tract. Identifiable by road configuration. Dates to Indian-British conflicts.	Record by marker and map. Historical development of the Grand River valley illustrated through architecture, folklore, historical land boundaries.
90-49	Historical Land Tracts Cayuga	Huff tract. Existing roads influenced by tract boundaries.	Should be marked as one in a series of land transactions in the historical development of the Grand River valley.
90-50	Historical Land Tracts Cayuga	Jones tract. Large acreage on both sides of Grand River. Road pattern still exists.	Major tract in series along Grand River.

Key	Item	Description	Potential
90-51	Historical Land Tracts Cayuga	River Range. Large acreage on both sides of Grand River. Includes development of Deans. Unclear if this is similar in nature to the named tracts of land.	One of series of designated lands with historical and political heritage.
90-52	Historical Land Tracts Cayuga	Young tract. Grand River frontage.	One of the series of tracts with river frontage and highway access.
87-53	Historical home Nelles Corner	Large frame building. Appears to have been an inn. Highway 3 access.	Located at road curve where alignment has left vacant space. If building has significance there is space for accommodating visitors.
102-54	Commercial fishing Port Dover	Most active port on Lake Erie. New and old boats and fishing facilities. Substantial dock and harbor area.	Only place to actually see fishing and dock operations. Highway goes through dock area. New draw bridge will add excitement. Major lakeshore attraction.
81-55	Draw Bridge Port Dover	New lift-bridge for large lake fishing boats. On lake front in the harbor area.	Signifies degree of permanence about Lake Erie fishing.
97-56	Fairgrounds Caledonia	On Grand River floodplain in town. Definite structure with buildings, fences, seating. Well kept. Direct highway access.	Of regional, seasonal focus Public access to river but no water orientation. Major open space. Expansion critically restricted. If fair moves use as park.
83-57	Old Mill Caledonia	Grist mill. Not used, in good structural repair. Sluice-ways crumbling, equipment unknown.	Located in town, on highway, on Grand River. Could be night-club, restaurant or recreation facility relating to Grand River and river edge.
83-58	Old Mill Caledonia	Grist mill. Not used, in good repair. Indirect road access. No information about equipment.	Has historical significance. Perhaps could be renovated for some re-use.
97-59	Fairgrounds Simcoe	Large open acreage; urban growth enclosing it. Some permanent structures.	Potential for becoming part of inner greenbelt as city expands. Link with golf course, Lynn River valley, existing park, Kent Creek bottomlands and existing lake within Simcoe and Patterson Creek.
97-60	Farmers markets Simcoe	Farm produce stands, small and large. Typical in area; fruits and vegetables. Privately operated.	Increasing urban and lake resort demand. Local feature, economic importance.
94-61	Native foods Delhi	Restaurants and specialty shops carry ethnic dishes and foods. Ukranian, Hungarian, German, Polish are represented.	Foods could be only a part of a much more identifiable ethnic expression such as festivals, costume, dance.

Key	Item	Description	Potential
87-62	Historical homes Vittoria	Exceptional grouping of 100+ year-old architecture. Houses, churches, stores. Little of character or structure has been lost.	Beginnings of a restored village. Organization of space between buildings to develop a unified core of main buildings. Other buildings could be added. Seat of some cultural group.
92-63	Historical marker Vittoria	Plaque giving significance of some buildings.	The history and significance could be brought to life and experienced.
101-64	Ontario Agriculture Research Station	Horticultural research station. Chain link fence. Large acreage. Government property.	Education value. Large acreage of public lands.
111-65	Outstanding buildings Vittoria	Historical and architecturally significant town buildings, private homes, commercial buildings and churches.	Buildings and their setting should be preserved and restored for their uniqueness.
111-66	Outstanding buildings Waterford	Large private houses and church of architectural value. All being used. Historical value unknown.	Very attractive tree-lined streets with large houses gives grand entrance from south.
111-67	Outstanding building Nanticoke	Major structural complex. 650-foot chimney.	Visual impact for miles on land and from Lake Erie.
111-68	Outstanding building Brantford	City of Brantford's new city hall. Large concrete complex, off main through streets.	A new image; nucleus for redevelopment of CBD. A break from tradition.
85-69	Historical church Brantford	Oldest protestant church in Ontario. Stained glass window, bell, communion service, Brant's grave.	Presently receiving large numbers of visitors; but preserved in natural setting. Parking facilities needed. Adjacent land could be park.
103-70	Institution Brantford	Mohawk Institute, 1827. For training of Mohawk children.	Curriculum unknown. Perhaps should be means of raising education and employment level.
103-71	Institution Brantford	Ontario School for the Blind. Campus complex, spacious attractive grounds.	National importance and reputation.

Wildlife Resources

△ *Natural Resources*

Key	Item	Description	Potential
156-1	Wolves Long Point	Have been killed off.	Restocking essential for balance of deer and food supply.
157-2	Deer Long Point	Critical over-population. Severe damage to natural feed supply.	Potential for mass starvation. Controlled hunting to reduce deer immediately. Re-introduce wolf for natural balance.
197-3	Ducks Long Point	Complete selection. Private hunting. Bag taken is far below capacity of marshes.	Far more ducks can be shot. Strategic breeding ground, perserve and manage.
197-4	Ducks Turkey Point	Same as above.	Same as above.
185-5	Pheasant Turkey Point Company	Population adequate for limited hunting. Private club.	